

Simplicius on the Planets and Their Motions

Philosophia Antiqua

A Series of Studies on Ancient Philosophy

Previous Editors

J.H. Waszink †
W.J. Verdenius †
J.C.M. Van Winden

Edited by

K.A. Algra
F.A.J. de Haas
J. Mansfeld
C.J. Rowe
D.T. Runia
Ch. Wildberg

VOLUME 133

The titles published in this series are listed at brill.com/pha

Simplicius on the Planets and Their Motions

In Defense of a Heresy

By
Alan C. Bowen



BRILL

LEIDEN • BOSTON
2013

Library of Congress Cataloging-in-Publication Data

Simplicius, of Cilicia.

[Aristotelis De caelo commentaria. English]

Simplicius on the planets and their motions : in defense of a heresy / by Alan C. Bowen.

pages. cm. – (Philosophia antiqua ; volume 133)

Includes bibliographical references and index.

ISBN 978-90-04-22708-8 (hardback : alk. paper) – ISBN 978-90-04-24171-8 (e-book)

1. Astronomy—Early works to 1800. 2. Simplicius, of Cilicia. 3. Aristotle. De caelo. I. Bowen, Alan C. II. Title. III. Series: Philosophia antiqua ; v. 133.

Q151.A8S5713 2013

523.4—dc23

2012035045

This publication has been typeset in the multilingual “Brill” typeface. With over 5,100 characters covering Latin, IPA, Greek, and Cyrillic, this typeface is especially suitable for use in the humanities. For more information, please see www.brill.com/brill-typeface.

ISSN 0079-1687

ISBN 978-90-04-22708-8 (hardback)

ISBN 978-90-04-24171-8 (e-book)

Copyright 2013 by Koninklijke Brill NV, Leiden, The Netherlands.

Koninklijke Brill NV incorporates the imprints Brill, Global Oriental, Hotei Publishing, IDC Publishers and Martinus Nijhoff Publishers.

All rights reserved. No part of this publication may be reproduced, translated, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior written permission from the publisher.

Authorization to photocopy items for internal or personal use is granted by Koninklijke Brill NV provided that the appropriate fees are paid directly to The Copyright Clearance Center, 222 Rosewood Drive, Suite 910, Danvers, MA 01923, USA.

Fees are subject to change.

This book is printed on acid-free paper.

For Pamela

CONTENTS

Preface	XV
Acknowledgments	XVII
Conventions	XIX
List of Figures	XXI

THE ARGUMENT

Introduction	3
Simplicius' Life and Writings	3
The Commentary on <i>De caelo</i> 2.10–12	6
The Place of 2.10–12 in the <i>De caelo</i>	8
Simplicius' Predicament	10
The Text and Translation	15
The Annotation	19
Planetary Retrogradation: A Review	20
1. The Heresy of Non-Homocentric Aetherial Motion	27
Aetherial Rotation	29
The Task Remaining	33
Simplicius on the Heavens	34
2. The Heretical Rejection of All Hypotheses	37
Simplicius, <i>In phys.</i> 2.2 193b22–35	38
Aristotle on Physical Theory and Mathematical Science	38
Physical Theory and Astronomy Recast	40
Simplicius and the Path Not Taken	50
The Need for Observation	51
The Empirical Limitations of Astronomy	52
A Question of Priority	54
Conclusion	57
3. Simplicius, the Apologist	59
Saving Aristotle	60
The Harmonized Aristotle	60
Aristotle, the Physical Theorist	61
Conclusion	67

Saving the <i>De caelo</i>	68
Saving the Late Platonists	69
Conclusion	71
4. Simplicius, the Historian	73
Simplicius and His Sources	73
Alexander of Aphrodisias	74
On Teleology	74
On the Isodromic Planets	76
On the Motion by Nature of Larger Spheres	76
On a Circular Argument	77
On an Ellipsis	77
On the First Problem of 2.12	77
On the Four Elements	78
On a Lexical Matter	79
Alexander and Porphyry	79
Conclusion	79
Eudemus of Rhodes	80
On Anaximander	81
Eudemus with Sosigenes	81
On Callippus	83
Conclusion	84
Claudius Ptolemy	84
Sosigenes	86
Coda	87
5. Conclusion	91

TRANSLATION

<i>In de caelo</i> 2.10. The proportionality of the planetary speeds	97
291a29–b10	97
470.29–471.11 Contextualization	97
471.12–14 Basic Astronomical Fact	99
471.14–28 This Fact Is Unexpected	99
471.29–472.4 Aristotle's Solution	100
472.4–7 Problem with This Solution	100
472.8–20 Alexander's Response	100
472.21–473.7 Problem of Natural Motion Remains	102
473.8–474.6 Another Solution	103

474.7–13	Alexander: The Isodromic Planets	104
474.14–30	Criticism	105
474.30–33	Alexander: The Upper Planets	106
474.33–475.8	Criticism	106
475.9–23	Plato on Planetary Speeds	106
475.23–476.10	Aristotle Reinterpreted	107
476.10–27	Rejection of Yet Another Solution	108
476.28–477.2	Problem of Isodromic Planets Remains	109
<i>In de caelo 2.11. The Sphericity of the Wandering Stars</i>		
291b11–17		111
477.5–14	Contextualization	111
477.14–23	First Argument for Sphericity	112
477.24–27	Question of Circularity	112
477.27–478.3	Alexander's Proposal	112
478.3–8	Criticism	112
478.8–14	Aristotle Reinterpreted	113
478.15–32	Further Explication of First Argument	113
291b17–23		114
479.3–10	Second Argument for Sphericity (Part 1)	114
479.10–23	The Meaning of 'dichotomos'	114
479.23–480.15	Lunar Phases and Sphericity	115
480.16–24	Second Argument for Sphericity (Part 2)	117
<i>In de caelo 2.12. The Proportionality of the Planetary Motions</i>		
291b24–292a18		119
480.26–481.22	Restatement of the <i>Lemma</i>	120
481.22–30	Alexander's Comment	122
292a18–b10		122
482.3–485.2	The First Problem and Its Solution	123
292b10–25		129
485.5–487.20	Further Explication of the Solution	130
487.20–488.9	Simplicius' Reconstruction of the Solution	134
488.10–14	Planetary Hypotheses Rejected	135
488.14–24	Planetary Hypotheses: Genesis	136
488.25–489.4	Criticism of the First Problem	136
489.5–11	Plato and the True Account	137
489.12–30	Alexander: The Elements Lack Soul	137
292b25–30		139
489.33–490.16	Second Problem and First Response	139

292b30–293a4.....	140
490.19–491.11 Second Response (or the First Continued)	140
293a4–11.....	142
491.15–492.11 Second (or Third) Response	142
492.12–24 This Response Assumes the Preceding	144
492.25–493.11 A History of Planetary Hypotheses	144
493.11–494.23 The Solar Hypothesis	146
494.23–495.17 The Lunar Hypothesis	148
495.17–497.24 Hypotheses for the Five Planets	149
497.24–499.15 Unwinding Spheres Hypothesized.....	154
499.16–501.21 Theorems on Homocentric Motion	156
501.22–502.19 The Unwinding Spheres Explained	160
502.19–504.3 The Total Number of Spheres.....	161
504.4–15 A Lexical Coda.....	164
504.16–505.19 The Failure of Homocentric Hypotheses	165
505.19–506.8 The Early Theorists Excused.....	167
506.8–16 The School's Proper Choice.....	169
506.16–22 Ptolemy's Criticism	169
506.23–507.8 Simplicius Puzzled	170
507.9–508.16 Eccentric and Homocentric Hypotheses	170
508.17–509.12 The Epicyclic Hypothesis	172
509.13–510.35 Aristotle and the New Hypotheses	173
Figures	179

COMMENTS

<i>In de caelo</i> 2.10	201
Comment 10.01. <i>De caelo</i> 291a29–34: A Question of Proportionality	201
Comment 10.02. <i>De caelo</i> 291a29: τὸ ἄστρον / ὁ ἀστήρ.....	201
Comment 10.03. <i>De caelo</i> 291a30: κινεῖται.....	203
Comment 10.04. <i>De caelo</i> 291b9–10: οἱ μαθηματικοί	203
Comment 10.05. <i>In de caelo</i> 471.1: «καταλαμβάνω» and Its Cognates	204
Comment 10.06. <i>In de caelo</i> 471.9: παραβολήs	205
Comment 10.07. <i>In de caelo</i> 471.11: οἱ περὶ Ἰππαρχον	206
Comment 10.08. <i>In de caelo</i> 471.20: Larger Bodies Move Faster by Nature	207
Comment 10.09. <i>In de caelo</i> 472.5–7: The Two Planetary Motions Thus Far	208
Comment 10.10. <i>In de caelo</i> 472.13–14: ἀναγκαῖον ... βίαιον μόνον	209

Comment 10.11. <i>In de caelo</i> 473.15: A Lacuna?	209
Comment 10.12. <i>In de caelo</i> 473.26–27: Planetary Bodies as Hypostases	210
Comment 10.13. <i>In de caelo</i> 474.26–28: Planetary Eccentricity	211
Comment 10.14. <i>In de caelo</i> 475.2–4: On Linear and Angular Speed ..	213
Comment 10.15. <i>In de caelo</i> 475.11–12: An Emendation	214
<i>In de caelo</i> 2.11	217
Comment 11.01. <i>In de caelo</i> 479.12: An Emendation	217
Comment 11.02. <i>In de caelo</i> 480.10–15: On Drum- or Lentil-Shaped Moons	218
Comment 11.03. <i>In de caelo</i> 480.17–19: The Shape of Eclipsing Bodies	219
Comment 11.04. <i>In de caelo</i> 480.19–21: On Flat or Convex Moons at Syzygy	220
Comment 11.05. <i>In de caelo</i> 480.21–23: Another Mistaken Argument	221
<i>In de caelo</i> 2.12	223
Comment 12.01. <i>De caelo</i> 291b35–292a1: On ‘Fewer Motions Than Some’	223
Comment 12.02. <i>De caelo</i> 292a3–6: Aristotle’s Occultation of Mars ..	224
Comment 12.03. <i>In de caelo</i> 481.12–15: Ancient Records of Occultations	225
Comment 12.04. <i>In de caelo</i> 481.22–24: The Encouragement Offered	226
Comment 12.05. <i>De caelo</i> 292a18–21: The Heavenly Bodies Ensouled?	227
Comment 12.06. <i>In de caelo</i> 485.10–12: Fewer Motions: Better or Worse?	229
Comment 12.07. <i>In de caelo</i> 487.20–488.2: Awareness of Retrogradation	230
Plato, <i>Timaeus</i> 40c3–d3	232
Plato, <i>Respublica</i> 617a4–b4	239
The Planetary Turnings	240
<i>Epinomis</i> 986a8–987d2	241
Epicurus, <i>Epistula ad Pythoclem</i>	241
Ptolemy, <i>Alm.</i> 12.1: Apollonius of Perga	244
Conclusion	247
Comment 12.08. <i>In de caelo</i> 488.20: Proclus on Sosigenes	248
Comment 12.09. <i>In de caelo</i> 488.21–24: On ‘Saving the Phenomena’ ..	251
Plutarch, <i>De facie</i> 923a	251

Archimedes, <i>Arenarius</i> 1.4–7	252
Seneca, <i>Nat. quaest.</i> 7.2.3	254
Stobaeus, <i>Ecl.</i> 1.25.3k	255
Plutarch, <i>Plat. quaest.</i> 1006b–c	255
Geminus, <i>Intro. ast.</i> 1.19–22	258
Conclusion	259
Comment 12.10. <i>In de caelo</i> 488.27–30: An Alternative Reading	260
Comment 12.11. <i>De caelo</i> 292b29–30: The Living Sources of Celestial Motion	261
Comment 12.12. <i>In de caelo</i> 493.15–17: The Third Solar Motion	262
Comment 12.13. <i>In de caelo</i> 494.9–12: An Error in the Solar Hypothesis?	264
Comment 12.14. <i>In de caelo</i> 494.20–22: The Length of the Day	264
Comment 12.15. <i>In de caelo</i> 495.5–8: On Latitude (πλάτος)	265
Comment 12.16. <i>In de caelo</i> 495.10–13: The Third Lunar Motion	265
Comment 12.17. <i>In de caelo</i> 495.13–16: An Error in the Lunar Hypothesis?	266
Comment 12.18. <i>In de caelo</i> 495.23–29: Values for the Sidereal Periods	268
Comment 12.19. <i>In de caelo</i> 495.29: The Particle «πως»	269
Comment 12.20. <i>In de caelo</i> 496.6–9: Values for the Synodic Periods	271
Comment 12.21. <i>In de caelo</i> 496.27–28: The Verb «ἤχω»	272
Comment 12.22. <i>In de caelo</i> 497.3: The Hippopede	272
Comment 12.23. <i>In de caelo</i> 497.24–504.3: The Unwinding Spheres ..	273
Comment 12.24. <i>In de caelo</i> 498.5–10: An Emendation	277
Comment 12.25. <i>In de caelo</i> 502.10–11: Sosigenes: The Unwinding Spheres.	278
Comment 12.26. <i>In de caelo</i> 504.24–25: Aristotherus	283
Comment 12.27. <i>In de caelo</i> 32.12–33.16: Simplicius <i>versus</i> Philoponus	284
Comment 12.28. <i>In de caelo</i> 504.28–29: The Size of Venus and Mars ..	288
Comment 12.29. <i>In de caelo</i> 504.29–30: Shadows Cast by Venus	289
Comment 12.30. <i>In de caelo</i> 504.30–32: The Size of the Moon	290
Comment 12.31. <i>In de caelo</i> 504.33: Moerbeke: The Digression	291
Comment 12.32. <i>In de caelo</i> 504.33–505.1: The Ancient Digit (δάκτυλος)	291
Comment 12.33. <i>In de caelo</i> 505.11–17: An Invisible Variation in Size ..	292
Comment 12.34. <i>In de caelo</i> 505.21–23: Homocentric Hypotheses: A History	293

Comment 12.35. <i>In de caelo</i> 506.2: Who Cares about the Number of Spheres?	294
Comment 12.36. <i>In de caelo</i> 506.11–15: Callisthenes and Aristotle	295
Comment 12.37. <i>In de caelo</i> 506.16: Simplicius on Ptolemy	296
Comment 12.38. <i>In de caelo</i> 506.22: Herophilus and the Nervous System	296
Comment 12.39. <i>In de caelo</i> 507.12–14: Simplicius and the Pythagoreans.....	297
Bibliography	299
Index of Passages	313
Passages in I.G. Kidd 1988–1999, vol. 1	324
Index of Names	325
Index of Subjects	328

PREFACE

This book has its genesis in work funded by a very generous three-year grant from the National Endowment for the Humanities that I began with Bernard R. Goldstein in 1988. Our project was entitled 'Early Hellenistic Astronomy and Its Historical Context', and its stated aim was

to produce a book about the introduction and use of geometrical models for predicting celestial phenomena quantitatively, a peculiar contribution of Greek astronomy in the third and second centuries BC to Western Civilization. This contribution marks a break with preceding Greek theory, which was geometrical but qualitative, and contrasts with contemporary Babylonian theory, which, though quantitative and predictive, was wholly arithmetical. In light of the debt of Hellenistic Greek astronomers to the Babylonians, we will determine what views and factors in Greek scientific, philosophic, and literary culture made the Greeks receptive to Babylonian influence.

The book never materialized and for good reason: as we quickly discovered once we started serious research and then subsequently explained in our reports, not only were the facts that we had presumed in making our proposal corrupt to their smallest details, the methods of 'learned' analysis by which these facts had been determined were hopeless if one's goal was knowledge rather than a pretty story willfully preferring but one of a number of conflicting possibilities. Mercifully, our Program Specialist at the NEH, Elizabeth Arndt, was quite supportive and willing to accept instead a series of articles in which we explored particular issues in the history of Hellenistic astronomy by critically evaluating current views and developing strategies of reading focused rigorously on what actually could be known.

Now, as some readers may recognize, our initial account of the great innovation in Hellenistic astronomy is very much a creature of the scholarly practice of using Simplicius' digression in his commentary on Aristotle's *De caelo* 2.12 to explain Aristotle's report of the homocentric theory of planetary motion in *Meta.* 1.8. (Of course, this is only *after* Simplicius' commentary has been laundered of the numerous defects perceived in it by modern historians.) And so I have returned on several occasions in the intervening years to Simplicius' testimony, concentrating mostly on how it has been misread but more recently on how it should be read. In truth, the account of Simplicius' discussion of Aristotle's reports and contribution to the theory of planetary motion to be found in the following pages redresses a misstep taken

so many years ago. It may also be seen, I suppose, as an act of penance—the next to come in a history of Hellenistic astronomy during the first centuries at the turn of the millennium that I am currently writing.

ACKNOWLEDGMENTS

It is only recently that I have moved from criticism of modern readings of Simplicius' commentary on *In de caelo* 2.12 to the related but vastly more interesting and worthwhile question of how one ought to read this text, that is, to the question of what Simplicius was trying to accomplish in it and why. Indeed, such progress was made possible by a year as a Visiting Member at the Institute for Advanced Study (2009–2010). For only there did I really have the leisure and the facilities to pursue my questions beyond their originally conceived limits. To Heinrich von Staden I am, thus, immensely indebted for his generous advice and support: I especially appreciate the hours spent with him discussing difficult passages in Heiberg's Greek text. To Serena Connolly, James Rives, Michael Lurie, William G. Thalmann, Nicole Belayche, Ruth Bielfeldt, and Judith Pfeiffer, classicists and historians who so kindly attended a seminar on Simplicius that I gave in the spring of 2010 and then offered very useful criticism and advice, I likewise extend warm thanks. I am also most grateful to Hannah Gutschow and Julia Bernheim for their expert proofreading of the translation and comments on *In de caelo* 2.10–11.

It is also a pleasure to thank Dave Herald for sharing his own study of Aristotle's report at *De caelo* 292a2–6 of a lunar occultation of Mars, and for preparing Figures 12.01 and 12.02. I am grateful as well to Clemency Montelle and the late Christopher Walker for their advice about some Babylonian texts.

Over the years, of course, I have had the privilege of engaging the help of numerous other scholars. To Bob Todd, Fabio Acerbi, Bernie Goldstein, Taïeb Farhat, Bernard Vitrac, Jim Lennox, Dirk Baltzly, and Christian Wildberg I offer my profound thanks and appreciation for all that they have done to assist me in bringing this project to light. Their generosity in answering questions and offering guidance is exemplary. To Andrea Falcon I am especially grateful for his showing me the final draft of his study of Xenarchus and his criticism of Aristotle's arguments in the *De caelo* for the existence of a special celestial matter, aether (now published by Cambridge University Press [see Falcon 2012]).

I am also pleased to acknowledge Carlos Steel for his great kindness in sending me photocopies of work (both unpublished and published but difficult to get) by the late Fernand Bossier on the Latin translations of

Simplicius' commentary by Robert Grosseteste and William of Moerbeke. These translations, though they belong to what scholars call the indirect tradition of transmission, are invaluable witnesses to Greek manuscripts antedating those which have survived. In this instance, they have enabled me to resolve numerous puzzles in Heiberg's Greek text.

The annotated translation and comments that I include in this book entail extensive revision of work published some years ago in *SCIAMVS* [2003b, 2008d]. I am grateful to the editors of that journal for permission to draw freely on this material and especially to Ken Saito for his generous support and encouragement during its preparation.

Finally, though my words fail, I thank my wife, Pamela, for her constant, good-natured support and warm encouragement over the years as I have pursued this and other projects. To her I dedicate this book.

With such support and counsel, it is hard to believe that errors remain. But I am sure that they do, and they will be mine. Yet none will, I pray, be so egregious as the one that beset my initial steps in this inquiry.

Princeton, NJ
June, 2012

CONVENTIONS

- () Parentheses enclose remarks that are parenthetical in Simplicius' exposition.
- [] Brackets enclose words and phrases typically implied by Simplicius' Greek but included explicitly in the translation in order to clarify its meaning.
- ⟨ ⟩ Angle brackets enclose text that is not in Simplicius' Greek. Their main use is in the *lemmata* to mark off the parts of Aristotle's text that Simplicius omits.
- ⟨⟨ ⟩⟩ Double angle brackets enclosing text in the translation signal text in Simplicius' Greek that should be deleted.

Italic text in the translation serves primarily to highlight the *lemmata*. It also marks the paraphrases and quotations of Aristotle's texts in Simplicius' comments on a given *lemma* and is used occasionally as well in the translation to convey the force of a single word.

LIST OF FIGURES

1. The conjunction and opposition of an outer planet with the Sun	22
2. The conjunctions of an inner planet with the Sun.....	22
3. The retrogradation of an inner planet	23
4. The retrogradation of an outer planet	23
5. The retrogradation of Venus in 2010	24
6. The retrogradation of Mars in 1997	25
7. Nested spherical shells	35
10.01. The eccentricity of a planet according to Simplicius.....	181
11.01.	
(a) Lunar phases: Conjunction to Full Moon	182
(b) Lunar phases: Full Moon to conjunction	183
11.02. The phases of a drum-shaped Moon: Conjunction to opposition	184
11.03. The phases of a lentil-shaped Moon: Conjunction to opposition	185
12.01. The occultation of Mars (–360 Mar 20)	186
12.02. The occultation of Mars (–356 May 4)	187
12.03. The hypotheses for the Sun	188
12.04. The length of the day	188
12.05. The motions of the Moon.....	189
12.06.	
(a) Placement of the third and fourth planetary spheres	190
(b) Generation of the hippopede	190
12.07. Homocentric motion (1)	191
12.08. Homocentric motion (2)	192
12.09. An analysis of compound motion	192
12.10.	
(a) Motion on a circle homocentric to the observer	193
(b) Motion on a circle eccentric to the observer	193
12.11. Motion on an epicycle with deferent homocentric to the observer	194
12.12. Apparent motion near apogee on a circle eccentric to the observer	195
12.13. Epicyclic planetary hypothesis in spherical shell.....	196
12.14. Eccentric planetary hypothesis in spherical shell	197

THE ARGUMENT

Ἀρχὴ δέ τοι ἦμισυ παντός
(Γνώμη ἀδέσποτος)

INTRODUCTION

SIMPLICIUS' LIFE AND WRITINGS

Little is known of Simplicius' life. He is often referred to as Simplicius of Cilicia, which presumably means that he came from the coastal region of Asia Minor that is south of the central Anatolian plateau and north to north-east of Cyprus. He was an adherent of that school of late antique Platonism which has been named 'Neoplatonic'. I will not use this designation, however, because it obscures the broader history of Platonism by casting it as a story of doctrinal purity and its contamination, and grievously misrepresents the spirit of late Platonism, the chief aim of which was to understand Plato's original meaning by close study of his writings and not to advance new speculation based on them.¹

From his own writings, we learn that Simplicius studied under two of Proclus' pupils: first, Ammonius (son of Hermeias) in Alexandria and, then, Damascius in Athens.² Sometime after the closure of the Athenian philosophical schools in AD 529 and the promulgation of laws affecting their ownership of property in 531, Simplicius left Athens, so the partisan Christian historian Agathias tells us,³ with Damascius and five others⁴ to take refuge at the court of the new Persian king Chosroes in Ctesiphon.⁵ With the signing in 532 of a treaty between Chosroes and Justinian that included provisions guaranteeing the safe return and acceptance of pagan philosophers without

¹ Cf. Hoffmann 2000, 610 (on the late Platonist view of innovation); Baltussen 2007, 274–275 and 2008, 1. See Hager 1983 on the coinage of the term 'Neoplatonism'. See Sedley 1989 on what the allegiance of a philosophical school to its founder or founders meant for the study of philosophy itself.

² For Simplicius' acknowledged debt to Proclus (AD 410–485), see Diels 1882–1895, 611.11–12, 795.4–5 and 12–14. On Ammonius, see Heiberg 1894, 271.19, 462.20–21; Diels 1882–1895, 59.23–24 and 30–31, 183.18, 192.14, 198.17, 1363.8–9. On Damascius, see Diels 1882–1895, 601.9, 630.35, 642.17, 644.10, 774.28–29, 778.27, 795.14.

³ See Agathias, *Hist.* 2.30.3–31.4.

⁴ They are Priscian of Lydus, Eulamius (perhaps Eulalius: the mss give both names) of Phrygia, Hermes and Diogenes of Phrygia, and Isadore of Gaza.

⁵ See Agathias, *Hist.* 2.30.3–4 with Hadot 1987b, 7–8. On Justinian's edict and how it contributed to the closing of the Athenian philosophical schools, see Watts 2004 and Wildberg 2006, 329–333. For an insightful study of this edict and why the schools in Alexandria survived, see Watts 2006.

requirement of conversion to Christianity,⁶ it seems, if we follow Agathias, that the refugees left the court of Chosroes and lived happily ever after.⁷

But where they actually went and stayed is a matter of dispute.⁸ According to some scholars today, it was to Harrân (Roman Carrhae, close by Edessa) in the Byzantine Empire but bordering Persia and still within the sphere of Chosroes' influence.⁹ But while there may be tenuous indications that he migrated to Harrân, there are serious problems with any claim that he actually stayed there.¹⁰ Other scholars maintain that Simplicius returned to Athens.¹¹ More recently, it has been suggested that, given Damascius' advanced age in 532, the late Platonic Athenian School may simply have dissolved, with Simplicius and his fellow students going their separate ways to establish their own schools in any one of a number of communities in the Roman East promising protection from Christian interference.¹² There is, however, evidence that Damascius returned to Syria and some reason to think that Simplicius and the other exiles accompanied him.¹³

In any event, it was in the period after 532 that Simplicius wrote (in order) his commentaries on Aristotle's *De caelo*, *Physica*, and *Categoriae*.¹⁴ There is a commentary on the *De anima* ascribed to Simplicius as well, but this attribution is controversial.¹⁵ Related to this is the question of whether Simplicius wrote a commentary on the *Metaphysica* and an *Epitome physicorum Theophrasti*, since the author of *In de anima* refers to the former twice and the latter once, in addition to making three references to a commentary on the *Physica*. So, if Simplicius did write the *In de anima*, he did so sometime after his commentary on the *Physica* as well as after his commentary on

⁶ This treaty was, however, no longer in force by AD 540.

⁷ Agathias, *Hist.* 2.31.3–4 with Hadot 1987b, 8–9.

⁸ See Golitsis 2008, 19–21 for an overview of the various locations that have been suggested.

⁹ See Hadot 1987b, 9–21. Ilsetraut Hadot, following Michel Tardieu, argues that there is evidence of a school of late Platonic thought in Harrân; but this has been denied recently [cf. Baltussen 2008, 13, 48–51].

¹⁰ See Watts 2005, 290–298.

¹¹ So, e.g., Cameron 1969, 22–25. But see Thiel 1999. Han Baltussen inclines to the view that Simplicius returned to Athens, where he lived 'in a kind of virtual exile, because he was unable to teach' [2008, 48–51, 112].

¹² Watts 2005, 298–315.

¹³ Golitsis 2008, 21–22, 203.

¹⁴ See Hadot 1987b, 22–23. Pantelis Golitsis [2008, 18–19] argues that Simplicius' commentaries were written between AD 535 and 545.

¹⁵ Bossier and Steel [1972] maintain that it is by Priscian; but Hadot [1987b, 23–27] argues that it is by Simplicius. See Huby et al. 1997, 105–140 for Steel's restatement and amplification of his case.

Aristotle's *Metaphysica* and his epitome of Theophrastus' *Physica*, neither of which is extant.¹⁶ Finally, there is Simplicius' commentary on Epictetus' *Enchiridion*, which is undatable in relation to Simplicius' other works.¹⁷

The question of where Simplicius resided after leaving Ctesiphon bears importantly on the question of his intellectual and institutional contexts, as well on the more general issue of the institutional continuity of late Platonism and how this connects with doctrinal continuity.¹⁸ But such matters will, I think, remain little more than an occasion for conflicting speculation until there is a fuller accounting of all the evidence in Greek, Latin, Syriac, Arabic, and so forth bearing on the period of Simplicius' life after 532.

Still, it is undeniable that Simplicius is addressing *readers* (οἱ ἐντυγχάνοντες or ἐντευξόμενοι) and, thus, that his commentaries are meant in the first instance as literary works for readers of considerable sophistication.¹⁹ Moreover, given that Simplicius' commentaries neither originated in any classroom nor were intended for use in such a context,²⁰ it follows that such indications of a school as one finds in his commentaries are a literary fiction.²¹ The question is, then, What is the nature of this fiction? Who are the informed readers constituting his school? Such hints as one finds in the *In de caelo* suggest that they were, or were imagined to be, late Platonists like himself. In other words, Simplicius, so far as one can tell, was writing either for contemporary Platonists in some community (to which he did or did not belong) or for readers imagined to be of like mind in a counterfactual present: his use of the first person plural in addressing his readers would suggest that he was not writing for those yet unborn.

As for the order in which these readers were to take up his commentaries, there is no reason to expect that his works were written in the order in which they were to be read. In fact, Simplicius himself affirms that Aristotle's *Physica* is to be read before his *De caelo*;²² and this, combined with the notions

¹⁶ See Hadot 1987a, for argument that Simplicius did write a commentary on Aristotle's *Metaphysica*.

¹⁷ See Hadot 1987b, 18–19, 27–28; 1996, 8–50. On the references in medieval Latin and Arabic texts to other lost works by Simplicius, see Hadot 1987b, 28–39.

¹⁸ See Watts 2005, 287–290.

¹⁹ See Todd 2008, 219–220.

²⁰ So Golitsis 2008, 16–18, 22. But see Baltussen 2008, 22, 122, 205–207 for the thesis that, though Simplicius' commentaries did not arise from actual teaching, they constitute instead a *summa philosophiae paganae* that was to serve as a resource for teachers as well as for students.

²¹ Note, for example, «μηδεὶς ἡμῶν» ('none of us') at the close of the comments on *De caelo* 2.12 [510.33].

²² 3.8–12, 5.35–6.4.

of spiritual progress and discipline that one finds in his commentaries, indicates that his commentaries on these treatises were to be read in the same order and, moreover, that his commentary on the *Enchiridion* was to be read first.²³

In the same vein, though one can list the numerous works that Simplicius cites, there is at this stage no sure way to specify the circumstances in which the materials cited were available to him. The commentaries themselves would suggest that he had access to a substantial library.²⁴ But the nature and range of the works collected, the owner, and the location are unknown.²⁵

THE COMMENTARY ON *DE CAELO* 2.10–12

Simplicius' is the only surviving commentary in ancient Greek on Aristotle's *De caelo*. It has typically been prized for the care of its citations of texts by earlier authors which are no longer extant. Indeed, it is fair to say that, until recently, Simplicius' *In de caelo* has been more mined for its Presocratic nuggets than actually read on its own terms.²⁶ To today's reader, however, such valuation pales against the appreciation of what the *In de caelo* reveals about how Simplicius and his philosophical school understood Aristotle's great cosmological work, and how their interpretation of it battled with Christian teaching, particularly, that teaching armed with philosophical justification by the renegade convert John Philoponus.²⁷

²³ See Golitsis 2008, 12–13; cf. Hoffmann 2000, 611–614.

²⁴ For a list of the books presumably in it, see Baltussen 2008, 211–215. On the libraries of the late Platonists, see Hoffmann 2000.

²⁵ On the more general question of the late Platonist libraries and the formation of philosophical *corpora* in Armenian, Syriac, Arabic, and Hebrew, see the collection of papers edited by Cristina D'Ancona [2007].

²⁶ See Hadot 1987b, 3.

²⁷ On Philoponus, see Sorabji 1996. It is ironic that for all his pains in challenging the later Greek Platonists as he struggled to supply a *rationale* for Christian doctrine in Greek philosophy, John was anathematized in AD 681, roughly a century after his death, for tritheism, an account of the Trinity born of the effort to settle a dispute using philosophical ideas [see Wildberg 2008, §§ 4.2–3]. On the late Platonist view of Christians, see Hoffmann 1987, 187–188. According to Simplicius, Christians are atheists who inconsistently value the heavens as the dwelling-place and throne of God but nevertheless prefer them to τὰ κοπρίων ἐκβλητότερα [370.29–371.4].

Incidentally, the phrase «τὰ κοπρίων ἐκβλητότερα» at 371.2 shows the full measure of Simplicius' palpable disgust with the Christian veneration of relics [cf. Hoffmann 1987, 201–203, 208–209]. But the exact nature of his polemic is elusive because we do not know which practices of personal hygiene and sanitation he is assuming. Ian Mueller's 'more worthy to be thrown out than dung' [2004a, 15] is possible but raises the questions of whom Simplicius

The present study, I hasten to say, is neither a general account of Simplicius' commentary on Aristotle's *De caelo* as a whole nor an essay on Simplicius the commentator, though either is undoubtedly an important *desideratum*. It is instead a narrowly focused analysis of *In de caelo* 2.12 with due attention to its place in the sequence of *In de caelo* 2.10–12.

But, the reader may well wonder, what actually warrants isolating Simplicius' comments on these three chapters of the *De caelo*? The warrant lies in three considerations. First is that Simplicius' commentary on 2.12 concludes with an astronomical digression, a much cited if not well-known passage which has been abstracted and reconstructed in modern times to form the bedrock of most histories of astronomy and science in Greco-Latin antiquity. Second, that 2.10–12 form a coherent, logical unit in the overall argument of the *De caelo*; and, as one might expect, the same is true of the commentary on these chapters. Third, that these chapters bring to the fore an acute problem regarding the motions of the heavenly bodies that Simplicius is able to suppress earlier in his commentary when dealing with Philoponus' attack on the *De caelo*.

This focus notwithstanding, the following study of Simplicius' commentary on 2.12 will, I trust, still be seen as a contribution to our understanding of the challenge of confronting the criticism of the *De caelo* put forward by John Philoponus,²⁸ as well as to the growing literature on Simplicius' strategies and methods as a reader and exegete of Aristotelian and Platonic works.²⁹

was writing for and where they lived that it was the practice to *throw* feces (human or animal) out. One philological issue is whether κόπρια and κόπρος are in fact the same. If they are, «ἐκβλητότερα» might better have the attenuated sense of 'more to be rejected': (Moerbeke [1563, 128.col.A: see Bossier 2004, cxvi–cxx] has 'abiectora' without translating «κοπρίων» and so inclines to such attenuation.) Curiously, however, in addition to the present passage, there are only two others in which Simplicius speaks of feces and in each he uses «κόπρος». (All three occur in the polemic of the *In de caelo*.) Further, so far as one can tell from these instances, ἡ κόπρος is something to which one descends [119.12–13] or something into which one falls [135.31–136.1]—in each case Simplicius presents himself as Heracles cleaning out the Augean stables—not something that one throws out. (Moerbeke [see Bossier 2004, 158.70, 180.7] has 'stercus' for both occurrences.) So, even if the phrase «τὰ κοπρίων ἐκβλητότερα» is found in numerous authors—Plutarch, for example, writes at *Quaest. conv.* 669a that, according to Heraclitus, corpses are more to be rejected (thrown out?) than κόπρια—it does not follow that, *if* κόπρος and κόπρια are the same there, they are the same here as well. Simplicius may just as well be thinking instead of 'shitty things', that is, items used to clean feces—the mosses, leaves, bits of cloth, and so forth used in ancient personal hygiene instead of toilet paper, for instance—and thus intend a much more vivid invective.

²⁸ I have found the papers by Han Baltussen [2007: cf. 2008, 172–209], Philippe Hoffmann [1987], and Christian Wildberg [1999] most illuminating on this topic.

²⁹ Baltussen 2008 is the first book-length study in English (at least) of Simplician exegesis.

At this juncture, however, I will elaborate only the second consideration and merely outline Simplicius' challenge in dealing with Philoponus in the *De caelo*, thus leaving study of the third consideration proper to the subsequent chapters. As for the first, though there will undoubtedly be readers who come to this book in the expectation of finding the means to advance the modern reconstructions of Simplicius' comments, I will say nothing now, mainly because these reconstructions constitute a misreading of Simplicius, as I trust will become clear in the following chapters as well as in my comments to the translation.

The Place of 2.10–12 in the De caelo

Chapters 10–12 of book 2 of the *De caelo* form a unit in Aristotle's argumentation that is defined by an explicit concern with the planetary motions and their proportionality, as well as by the idea that the pursuit of these concerns entails consultation of scientific works.

Consider the immediate context of these three chapters as defined by chapter 8. This chapter opens by asking whether, given that the heavenly bodies (the fixed stars) and the heavens (celestial sphere: οὐρανός) as a whole are observed to change position, it is the case that:

- both the celestial sphere and the fixed stars are at rest, that
- both are in motion, or that
- one is in motion while the other remains at rest [289b1–4].³⁰

After some deliberation, Aristotle concludes that it is reasonable (εὐλογον) to hold that the fixed stars do not move on their own but are fixed in circles (in the celestial sphere) that rotate with a speed which varies directly with their distance from their center of rotation, the Earth [289b5–290a7]. Next, he argues that since these bodies are spherical, they must either rotate or roll, *if* they move by themselves; and, thus, that since they do not in fact appear to rotate or to roll, it is reasonable that they do not move by themselves [290a7–29]. And so he concludes:

This is why it would also seem reasonable that the entire heavens and each heavenly body be spherical, since the sphere is the most useful of figures for motion within itself (given that it can move most quickly in this way and, most of all, occupy the same place) and least useful for motion forward, since [this shape] is least like things capable of motion of their own accord (given that it lacks an appendage or protuberance like a rectangle but stands farthest

³⁰ The related question of whether the Earth rotates is taken up in 2.13–14: in 2.8, Aristotle simply asserts that it does not [289b4–5].

apart in shape from bodies capable of progression). Since, then, the heavens must perform a motion within themselves but the other [bodies] must not go forward on their own accord, either would reasonably be spherical, since, in this way, the former will be in motion and the latter, at rest.

[*De caelo* 290a36–b11]

That is, given the conclusion that the fixed stars do not move on their own and yet make a daily revolution about the Earth, and that the celestial sphere carries these bodies round as it rotates about an internal axis, it follows reasonably that all such bodies are spherical—the celestial sphere because this shape is best suited for rotation and the fixed stars because sphericity befits what is by itself immobile.³¹

Chapter 2.9 takes this up by focusing on a feature of celestial motion that has not yet been addressed explicitly in the *De caelo*, the motion of the wandering, as opposed to the fixed, stars. But it does so obliquely by attacking immediately (one version of) the Pythagorean contention that the planetary motions produce a *ἄρμονία* [290b12–291a6], and then showing that the absurdity of this contention affords proof by *modus tollens* that the heavenly bodies are in fact spherical and do not move on their own accord, the very point of chapter 2.8.

In chapter 2.10, Aristotle recovers from the ‘false start’ of chapter 2.9. He breaks new ground by introducing the distinction between fixed and wandering stars, that is, between the daily motion westwards performed by all heavenly bodies, but most notably by the celestial sphere, and the slower motion eastwards performed in addition by seven of these bodies. The question at issue, though connected to chapter 9, takes him in a new direction. For, though he rejects the Pythagorean idea of *ἄρμονία* in the planetary motions, he finds well worth study the related matter of proportionality (*ἀναλογία*) in the motions by which these seven bodies progress in the direction opposite to the daily rotation. To determine and explain such proportionality as there may be, however, Aristotle abandons the Pythagoreans and turns instead to those whom he calls *μαθηματικοί*, the scientists who study the heavens using mathematics.³²

³¹ This conclusion, though established with an eye to the fixed stars, is held to be true of all heavenly bodies, both fixed and wandering: cf. 290a12–14, 291b17–18. Aristotle never explains how it is that a fixed star or planet can be immobile *per se* when it is composed of aether, a simple body that moves in a circle about the center of the universe *by nature*. Likewise, he does not address the question of why we can see the fixed stars and planets but not the spheres that move them.

³² On this term and its translation, see Comment 10.04, pp. 203–204. It is worth noting that, for Aristotle, the Pythagorean treatment of the heavens did not count as *μαθηματική*.

The next two chapters continue in this vein: both concern the planets and both take recourse (though not exclusively) to the science of the heavens for information and arguments. Chapter 2.11 argues on empirical grounds that the planets are spherical in shape and thus secures the conclusion of chapter 2.8 about their not moving of their own accord. Chapter 2.12, which now (and only now) allows that the planets have *more* than two motions, undertakes to explain the obvious lack of proportionality in the number of motions that these bodies have as well as in the number of bodies that these motions move.

In chapters 13 and 14, the last of book 2, Aristotle takes up the questions of the position of the Earth in the cosmos, its motion, and its shape. Granted, the answers given here do connect to preceding claims: the cosmology of the *De caelo* is, after all, coherent. Still, these chapters offer nothing about planetary motion *per se* and so mark the end of the discussion of planetary motion.

Simplicius' Predicament

Simplicius' primary purpose in writing his commentary on the *De caelo* is in part the same as in his other commentaries on Aristotle's works—to enable the reader or student to grasp Aristotle's meaning, thereby turning the eyes of his soul to the truth and promoting his assimilation to the divine.³³ Related to this is Simplicius' narrower aim in his *In de caelo* of repudiating the impiety and atheism of those who deny the truth as it is found in the *De caelo*. Consider the prayer which concludes Simplicius' commentary:

To you, Lord of the entire cosmos and Craftsman of the simple bodies in it, for what has come into being through you do I offer in praise these words out of eagerness to survey the magnitude of your works and to reveal them to the worthy so that in reckoning nothing petty or human about you, we adore you for the preeminence which you have in relation to all that is created by you.³⁴

This prayer, which gives voice to the underlying and pervasive religious motive of the *In de caelo*,³⁵ highlights the fact that one of Simplicius' subsidiary aims is to ensure that the worthy, presumably, those with the charac-

³³ On the eyes of the soul, see Plato, *Resp.* 533c7–d4 and *Soph.* 254a4–b1. In his *In de caelo*, Simplicius writes instead of those whose passions and related opinions blind the eyes of the soul: see 74.4–5, 141.19–21. On assimilation (ὁμοίωσις), see, e.g., 483.15–19 and Chapter 2, esp. pp. 54–56. On the late Platonic curriculum, see Hoffmann 2000, 611–614; Golitsis 2008, 10–14.

³⁴ 731.25–29. Cf. Hoffmann 1987, 203–210; Todd 2008, 220–221.

³⁵ See also the prayers at the close of his *In cat.* [Kalbfleisch 1907, 438.33–36] and *In Epict. ench.* [Hadot 1996, 454.6–15].

ter, ability, and education to understand their relation to the divinity, do so properly and, specifically, that they ascribe nothing petty or human to this divinity.

But what is it that Simplicius wishes to forestall by his commentary? What specific sins, as it were, does he seek to obviate in explicating the *De caelo*? The answer is not to be found at the very start of the treatise—there Simplicius meets the school's requirement to identify the single objective or theme (σκοπός) to which the *De caelo* is addressed³⁶—but only later, after he deals with some objections to Aristotle's argumentation in 2.1 offered by Xenarchus of Seleucia (first century BC)³⁷ and then turns to John the Grammarian, also known as John Philoponus.³⁸

It is important to bear in mind that Simplicius, like any late Platonist, had a very well-defined agenda in reading Plato and Aristotle, and that his conclusions about their meaning are from the standpoint of scholarship today untenable. But it is equally important to recognize that there is no way to explicate Simplicius' predicament in dealing with Philoponus unless we start with *his* interpretation of Plato and Aristotle. On this basis, then, I will amplify what I take to be his predicament in the following chapters; but for now it will suffice to record that, for Simplicius, the truth, as enunciated by Aristotle, is that:

- the heavens are composed of a simple body called aether, the nature of which is to move in a circle;
- since its natural motion has no opposite, aether is immutable; it cannot change in any respect other than place;
- aether and the heavens are, therefore, eternal, and, thus
- radically unlike the sublunary elements (earth, water, air, and fire), elements which are by nature mutable and perishable because each has a natural motion to or from the center of the cosmos in a straight line and, thus, an opposite (unnatural) motion.

³⁶ 1.1–6.27 (esp. 4.25–31, 5.35–37) for the commentary's prologue and the assumption that the *De caelo* has a single objective.

³⁷ See Falcon 2012, esp. 51–126 for a thorough study of Xenarchus and his criticisms.

³⁸ On the diverse ways in which Simplicius refers to Philoponus, see Hoffmann 1987, 184–199. As Hoffmann notes, Simplicius never uses the epithet 'Philoponus', a term which might otherwise indicate membership in a group of Christian lay workers [Watts 2006, 213–219], because it also designates a philosophical virtue and so would, in his view, be most inappropriate. Note: «φιλοπόνως» applied to Alexander's work and «διὰ φιλοπονίαν» to Damascius [316.3 and Diels 1882–1895, 129.32, 291.21, 795.16: cf. 795.34 (Alexander is φιλοπώνωτος of Aristotle's interpreters)].

Now, Xenarchus' criticisms were not, it seems, a real problem for Simplicius. At no point does Simplicius even acknowledge that Xenarchus was in fact a Peripatetic, which means that, for Simplicius, Xenarchus was not a credible reader of Aristotle.³⁹ Moreover, Simplicius already had in hand Alexander's counter-arguments and he is typically content to deploy them with some refinements.⁴⁰ But most important, I think, is that Xenarchus' attack posed no substantial threat to the late Platonic reading of Aristotle: his criticisms were, it seems, focused on particular assumptions in the arguments that there is a fifth simple body, aether, and came without any indication that their aim was to deny the eternity and, hence, the divinity of the heavens.⁴¹ In short, Xenarchus posed no certain challenge to any fundamental tenets of late Platonic piety.

But Philoponus was a different matter altogether. His aim was to defend the Christian account of creation in *Genesis*, not by citing Scripture, but by attacking on their own terms the arguments in Aristotle's *De caelo* for the eternity of the heavens and, hence, of the cosmos. To Simplicius, this attack demeaned the heavens by supposing them to be, like the sublunary world, subject to generation and decay. As he saw it, Philoponus was a blasphemer whose atheism was so entrenched that he likened the divine Craftsman (Δημιουργός), the maker of the visible world, to an ordinary human craftsman and held His work, the divine, eternal heavens, to be no better than the petty, perishable objects that fill human lives.

As Simplicius writes after dealing with the Xenarchan assault on Aristotle's aether:

These objections Xenarchus has raised against the hypotheses handed down from Aristotle. But one among us,⁴² a hunter of fame, so it seems, has emerged,

³⁹ See Wildberg 1999, 115–120 on how the late Platonists read Aristotle. Why Simplicius omits this detail about Xenarchus' philosophical affiliation is a good question. It might be a feature of his own polemic, a way of diminishing the seriousness of Xenarchus' views. Alternatively, *if* Simplicius had access to Xenarchus only through Alexander's (now lost) commentary on the *De caelo*—Alexander is the only authority that Simplicius cites in rejecting them—then Alexander may be the one responsible for suppressing this fact. See Falcon 2012, 20–25, 42–47, 167–174 on the nature of Peripatetic readings of Aristotle in the first century BC and the treatment of Xenarchus by Alexander and the later commentators.

⁴⁰ In six of the 10 occasions in which Simplicius cites Xenarchus' criticisms of Aristotle's argument for the fifth simple body, Simplicius cites Alexander's rebuttal(s) and then adds some considerations of his own: cf. 13.22–14.29, 21.33–23.10, 23.11–31, 23.31–24.21, 42.6–16, 50.18–52.18. It is unclear whether Xenarchus' reported description of void (τὸ κενόν) as what is receptive (τὸ δεκτικόν) of body, rather than as what is capable of receiving (τὸ οἶόν τε δέξασθαι) it [286.2–13], bears on his arguments against aether [Falcon 2012, 31].

⁴¹ See Falcon 2012, 31, 113–119.

⁴² 25.23 τῶν δὲ τις ἐφ' ἡμῶν: Simplicius is, I suspect, not thinking of Philoponus as a mere

a critic of Aristotle, who palms off some of Xenarchus' objections [as his own] and collects others like [them], and who sets for himself the objective, his *entire* objective, as he says, to demonstrate that the cosmos is perishable, as though he will get some great prize from the Craftsman if he demonstrates that He is a craftsman of perishable things alone and of nothing imperishable. On account of this desire, he proposes to contradict what is said here by Aristotle through books of many lines not only in the hope of astounding the witless by quantity but also, I think, of turning the many (and especially, the more refined) from the study of his gross nonsense, with the result that his writings, which remain unexamined, have afforded the writer renown for wisdom from the mere fact that such a great number of lines contradict Aristotle.

But I know that such brazen acts, which seem to blossom among the witless, vanish in a few days just as the so-called Gardens of Adonis.⁴³ And for my part, in proposing to clarify to the extent possible Aristotle's treatise *De caelo*, I thought that I should not overlook the objections of this man, [objections] which trouble none of the educated but rather those of the uneducated who always take pleasure in strange things and are weighed down by the good repute of ancient men and still further think that they revere God if they believe that the heavens, which exist for the service of men, possess nothing special in relation to things below the Moon and if they assume that [the heavens] are perishable in the same way as they. For these men who think that these objections support their belief about God hold [them] in great honor, though they know nothing of these [matters] and still less of Aristotle's [views] against which they dare to raise them, but chatter to one another and claim with youthful insolence in response to us that the doctrines of the philosophers are overturned.

Thus, for the sake of these [philosophers] and of those more disposed to listen, and in order that Aristotle's treatise *De caelo* and its reverent conception of the universe remain undisputed in their good repute of old, it seemed right to me both to set forth these objections and to resolve them to the extent of my ability, since putting both the objections and their solutions together with my comments on the treatise seemed quite fitting.⁴⁴

Therefore, it seemed right to me to help those who have been led by his insolence into scorn of Aristotle's [views] by showing that his vainglorious lack of education is to be spat on.⁴⁵

contemporary but as a (former) student in the same school of late Platonism: cf. 26.19–21. Moerbeke has 'modernorum quidem' [Bossier et al. 2004, 34.41]: cf. Wildberg's 'But one of our contemporaries' [1987, 39].

⁴³ See Hoffmann 1987, 196–197 on the theme of the Gardens of Adonis in Simplicius' polemic.

⁴⁴ 25.22–26.17. This attack is reprised in Simplicius' commentary on Aristotle, *Phys.* 8.10 [Diels 1882–1895, 1326.38–1327.11: see Wildberg 1991].

⁴⁵ 26.28–31.

Philoponus was plainly an embarrassment. Though raised in late Platonic thought by the same teacher and in the same school as Simplicius,⁴⁶ he converted to Christianity and began a *philosophical* assault on some key doctrines of his former school. His attack on Aristotle's arguments for the eternity of the cosmos was especially dangerous in that it focused on Aristotle's argument that the heavens were composed of aether. The problem here was that this argument is an argument not merely for the existence of a special matter that moved by nature in a circle, but for the existence of a special matter that moved by nature in a circle *about the center of the cosmos*. Thus, for Aristotle, given that the heavenly bodies do not move of their own accord but are carried round by spheres, it was an argument requiring that all these spheres rotate about the Earth, the body at the center of the cosmos, a view that Aristotle develops in *Meta.* A.8.

Of course, Philoponus quite reasonably turns this requirement against Aristotle: after all, astronomers had since the first century BC been using epicyclic and eccentric spheres to account for planetary motion.⁴⁷ But curiously enough, when Simplicius turns to this particular bit of Philoponus' corrupt and corrupting nonsense, he first asserts that, for Aristotle, motion is circular if it is about *a* center and that the claim about its having to be about the center of the universe is but a concession to earlier astronomical theory. Then, he mounts a polemical diversion in which he takes Philoponus' point to concern the rotation of the planets (and not also their revolution) and asks whether it is through misreading Ptolemy's *Canones manuales* or *Handy Tables* that Philoponus learned that the planetary bodies rotate about their own centers.⁴⁸ The upshot is that, whatever the warrant for Simplicius' focus on rotation—whether it lies in something Philoponus wrote or whether it is merely a polemical *riposte*—Philoponus' attack is nicely deflected. Indeed, only later in commenting on 2.12, long after Philoponus' objections to the Aristotelian aether have been answered, does Simplicius again take up, without mentioning Philoponus, the question of the homo-

26.30 *κατάπτυστον*: or less concretely, 'despicable', as Moerbeke [Bossier et al. 2004, 36.82] has it [cf. Wildberg 1987, 40].

⁴⁶ Both Simplicius and Philoponus studied under Ammonius in Alexandria: see 26.19–21 for an allusion to Philoponus' background in late Platonic exegesis. Simplicius, however, affirms that they never met: see 26.17–19 (with Hoffmann 1987, 197–199 on Philoponus' 'anonymity' in Simplicius' writings).

⁴⁷ See 32.1–7 [= Wildberg 1987, F7].

⁴⁸ See Comment 11.05, p. 221. Ptolemy was active in the middle parts of the second century AD [cf. Toomer 1978, 186–187].

centric planetary theory developed in *Meta.* A.8, and defend his own conviction that, in matters concerning how the planets move, it is better to follow planetary hypotheses developed long after Aristotle.

So, the astronomical digression (παρέκβασις) at the close of *In de caelo* 2.12 is, logically speaking, a part of Simplicius' attempt to deal with Philoponus. But placed and cast as it is, this digression turns out in fact to be a delicate *apologia* that negotiates the need to depart from Aristotle's explicit teaching about the motions of the planets, all the while avoiding Philoponus' impious denigration of the heavens. But there is more. This departure from Aristotle involves more than a simple preference for the sort of planetary theory found in Ptolemy's works. It is, as I will show, a nuanced argument that this departure is not a heresy but still in accord with Aristotle's teaching. Surprisingly, however, this defense against Philoponus' heresy broaches in turn another heresy of its own, one far more radical than anything envisaged by Philoponus—the idea that *none* of the current astronomical theories or hypotheses is adequate and that what is *yet* to be expounded is a physical theory identifying and explaining the real planetary motions. I will return to this 'heresy' in the following chapters, where I suggest reasons why Simplicius is content to raise it and then to leave it without direct comment.

The Text and Translation

To supplement the chapters analyzing *In de caelo* 2.12, I have included in this volume an annotated translation of *In de caelo* 2.10–12. I have deemed this advisable for several reasons. First, as I have already indicated, the *technical* points at issue in *In de caelo* 2.12 have *In de caelo* 2.10–11 as their immediate context, and so understanding these points and how they arise requires a sure grasp of what precedes. Moreover, the numerous translations of the astronomical digression concluding *In de caelo* 2.12 that have been offered in English since the beginning of the 20th century are not only incomplete, they are typically supported by anachronistic analysis. As for the lightly annotated version of Simplicius' commentary on *In de caelo* 2.10–12 found in Mueller 2005, though it is vastly better in offering this passage in its full context, it is not designed for readers with the purpose at hand and, indeed, is too often uncertain or misleading. Then too, as I will explain, access to Fernand Bossier's unpublished papers bearing on the text of *In de caelo* 2.10–12 has allowed me to supersede the annotated translation that I published several years ago in *SCIAMVS* [2003b, 2008d]. Finally, my study of *In de caelo* 2.12 is very much part of my understanding of the Greek text and its meaning, and supplementing this study with an annotated translation

has seemed a good way to develop the thread of my analysis without losing it in the numerous interpretative details supporting it—to say nothing of explaining technical issues to those unfamiliar with Hellenistic astronomy or addressing alternative accounts.

Simplicius' commentary on Aristotle's *De caelo* divides that treatise into sections or *lemmata* which are cited in abbreviated form by quoting the opening and closing words. Thus, for example, the *lemma* for the first section of the commentary on *De caelo* 2.11 reads:

'The shape of each of the heavenly bodies' up to 'clear that they must be spherical in bulk'.[477.3–4]

The assumption is that the reader will have a copy of Aristotle's treatise at hand. And so the problems begin. In the first place, it is hardly certain that a reader today will have a Greek text of the *De caelo* in hand and ready for this exercise or, for that matter, even an English translation. For this reason then, as Robert Grosseteste and others later, I have decided to expand each of Simplicius' *lemmata* by translating the entire section of the *De caelo* at issue. Yet, while this may aid the reader, it exposes another problem: Simplicius' *lemmata* do not always agree with the received text used today; and, what is even more surprising, they are frequently at odds with the quotations and paraphrases found in his commentary on the text lemmatized.

To address these problems, one might choose, as Mueller [2005] does, for instance, to homogenize the *lemmata* and the quotations and paraphrases by adapting the translation of the sections of the *De caelo* under commentary. But this will not do. There is no warrant for assuming that the *lemmata* from Aristotle's *De caelo* in Simplicius' text come from the same source as his quotations and paraphrases.⁴⁹ Indeed, it is unwise to suppose that the *lemmata* and the material quoted and paraphrased in the comments themselves were even made by the same person.⁵⁰ Consequently, in rendering the expanded *lemmata*, I have relied strictly on modern editions of Aristotle's *De caelo* and have relegated to footnotes my remarks about any differences

⁴⁹ See Moraux 1965, clxxxiv–clxxxvi: cf. 1954 on the complex relation between the text of Simplicius' commentary and the medieval manuscripts of Aristotle's *De caelo*. On the history of the transmission of the Aristotelian corpus, see Moraux 1970, 1–40, 67–94.

⁵⁰ Paul Moraux concludes that the *lemmata* were taken from a different text of the *De caelo* than the one which Simplicius used in writing his quotations and paraphrases, and that they were entered at some unknown date after the comments were completed [cf. Moraux 1954, 151–154, 179]. As Heinrich von Staden, however, has suggested in conversation, it would perhaps be better to imagine that Simplicius' original *lemmata* were revised by a later copyist unconcerned with the quotations and paraphrases in the comments proper.

with Simplicius' abbreviated *lemmata*. After all, since we have only Simplicius' *lemmata* and not the full text of the *De caelo* that he used, there seems little sense when presenting Aristotle's text in full to combine it with readings from Simplicius' and thus to imply a text that may not have existed. At the same time, I have preserved the fact that the text quoted or paraphrased in the comments proper differs on occasion from the text of the *lemmata*.

For the modern text of Aristotle's *De caelo*, my primary source is Moraux's critical edition since it makes extensive use of the indirect tradition.⁵¹ I have also used Heiberg's edition of 1894 for the text of Simplicius' commentary.

But *caveat lector*. Fernand Bossier has made it clear that Heiberg's edition needs revision in light of two recent advances in our understanding of the indirect tradition of the text of the *In de caelo*.⁵² First, there is D.J. Allan's discovery of a Latin translation by Grosseteste (d. 1253) of Simplicius' commentary (with fully expanded *lemmata*) on all of *De caelo* 2 and the opening section of the commentary on *De caelo* 3. This plainly bears on our understanding of the Greek text of Simplicius' commentary because Grosseteste drew on a manuscript unaffiliated to the earliest ones that have survived to this day. (The earliest extant Greek manuscript of the commentary derives from the 13th/14th century.)⁵³ Next, as Bossier argues, at some time in 1264–1265, William of Moerbeke (d. 1286) prepared a translation of a lengthy section of the astronomical digression in *In de caelo* 2.12 [492.25–504.32] for Thomas Aquinas, a document which Bossier discovered and named the *Fragmentum Toletanum*.⁵⁴ In preparing the *Fragmentum*, Moerbeke used a manuscript related to Mutinensis gr. 161; whereas in making his full translation of the commentary in 1271, he revised this earlier translation using a better manuscript that enabled him to fill in various gaps in the *Fragmentum*.⁵⁵ Heiberg's edition, however, antedates the discovery of Grosseteste's

⁵¹ See Moraux 1965, clviii–clxxii.

⁵² See Bossier et al. 2004, xix–xxi, ciii–cxvi: cf. Bossier 1975, Bossier 1987.

⁵³ See Bossier 1987, 289–290; Bossier et al. 2004, x.

⁵⁴ See Bossier et al. 2004, xxii–xxvi (for a description of the *Fragmentum* and of the two manuscripts in which it appears), xxvii–xxxix (for argument that Moerbeke is the author of the *Fragmentum* and that he wrote it ca 1265), xliii–xlix (for the claim that the *Fragmentum* was intended for Thomas Aquinas and was used in the latter's commentary *In meta*): cf. Bossier 1987, 298–308. But, *pace* Bossier, the facts that Moerbeke translated the text for someone interested in the homocentric theory of *Meta*. A.8 and that Thomas used it in his *In meta*., are only consistent with the inference that the translation was actually prepared for Thomas; they do not warrant it [cf. Musatti 2006, 527–532].

⁵⁵ See Bossier et al. 2004, xxxii–xxxviii, xli–xliii: note also lxxxv [with Bossier 1987, 305–308] on Thomas' use of the translation of 1271 in preparing his *Expositio in libros de celo et mundo*.

translation; moreover, though Heiberg rightly recognized the immense value of Moerbeke's translation in establishing Simplicius' text,⁵⁶ he places undue confidence in the edition published in 1540 of the translation of *In de caelo* made in 1271.⁵⁷

Regrettably, Bossier died shortly after the publication of the first volume of his edition of Moerbeke's translation of Simplicius' commentary on the *De caelo* [Bossier et al. 2004], and work on this translation has come to what one can only hope is a temporary halt: while it is very good to have a proper edition of Moerbeke's translation of the commentary on *De caelo* 1, the edition of Moerbeke's version of the commentary on books 2–4 will be invaluable.

As it is, however, my own work on Simplicius was greatly assisted when Carlos Steel very graciously sent me a copy of Bossier's typescript edition of Grosseteste's translation of Simplicius' commentary on *De caelo* 2.10–12 [470.27–510.35] and included a copy of Bossier's handwritten draft of his edition of Moerbeke's translation of 1271 of the same passage [470.27–491.11] along with a copy of Bossier's typescript edition of the text originally translated by Moerbeke in the *Fragmentum Toletanum* [492.25–504.32]. As the reader will see, I have made liberal use of these papers in understanding and rendering Heiberg's Greek text, and am much indebted to Professor Steel for his kindness in supplying me with them.

Simplicius' Greek throughout his commentary on *De caelo* 2.10–12 is in the main pedantic and prolix with many long sentences that are both compound and complex, though there are on occasion passages that are elliptical and crabbed. Moreover, in spite of Simplicius' tendency to explain his terms, there remain sentences which the modern reader at least may find difficult because they draw on the technical vocabulary of Platonic philosophy in the sixth century AD or of Hellenistic astronomy.⁵⁸ I have tried to deal with all this by supplying in square brackets what is not explicit in the Greek whenever this seemed necessary or likely to make the meaning easier for the reader to grasp. At the same time, I have tried, so far as it is reasonable and I am able, to capture Simplicius' technical vocabulary and to preserve the logical structure of his sentences. I have not, however, been a slave to the

⁵⁶ It is worth noting that no Greek source preserves the end of Simplicius' commentary on *De caelo* 1: for that we are wholly dependent on Moerbeke [see 361.5–364.14].

⁵⁷ See Bossier 1987, 293–298; Bossier et al. 2004, ciii–cxvi, cxxv–cxxxiii.

⁵⁸ For a fuller description of Simplicius' style, see Steel's account in Huby et al. 1997, 114–115.

dogma that key words in Greek must have unique renderings in English. Still, though I trust that the resulting translation is sufficiently reliable to support fairly close work on the many questions of Simplicius' meaning and method, I confess that I will not be disappointed if readers throw up their hands and turn to the original to see what they can make of it on their own. In fact, I have included page and line numbers of Heiberg's edition of the Greek text in the margin of my translation for this purpose.⁵⁹ In the same spirit, I have also put in italics those passages from Aristotle's writings (mostly the *De caelo*) that Simplicius quotes without specific notice, along with a footnote giving the proper citation.

The Annotation

The annotation, that is, the footnotes to the translation and the comments, is designed, as I have already indicated, to assist readers by explicating the many issues that they should understand in order to assess what Simplicius actually offers in his account of *De caelo* 2.10–12. Readers may well disagree with the claims and arguments made. Still, I trust that this annotation will at least help them to avoid missteps, mine included, and that I have not missed the mark too often in guessing what might be helpful.

But let me clarify this further. Though some readers might wish otherwise, what I have *not* done in the annotation is to engage systematically and directly the voluminous literature offering reconstructions of the arrangement of homocentric spheres that Simplicius describes in the astronomical digression concluding his comments on 2.12, a digression that includes an interpretation of Aristotle's cosmology in *Meta.* Λ.8: all I have done on this score is to note the failings of its tacit assumptions. The reason is that my overriding aim in this book is to establish a reading of Simplicius *e Simplicio*. Thus, in annotating the translation, I have included only such information as will allow readers to confront Simplicius' interpretation *on their own* without having to plumb the many layers of learned speculation that now lie between the text and them. My hope is that this will encourage readers to view these reconstructions critically rather than simply acquiescing to them or rashly setting out directly to tinker with their details or even just turning tail in the face of their billowing mathematical exegesis.

⁵⁹ My rule in positioning the numbers was to put them beside the line in English where the first word of the line in Greek is translated. The outcome is hardly exact so far as the actual line count goes; but it should be good enough to allow readers to move between my translation and Heiberg's edition, if they so wish.

Admittedly, this accords with my own conclusion that these reconstructions of the astronomical import of Simplicius' interpretation, reconstructions which go back to Schiaparelli [see 1925–1927] in the 19th century and are substantially no more than variants of a project and way of reading Simplicius that was codified by Thomas Heath [1913],⁶⁰ must be viewed today as an egregious example of how scholars and their communities read themselves into the past.⁶¹ Moreover, as will become clear in the following chapters, it fits my firm conviction that Simplicius' commentary on *De caelo* 2.10–12 is interesting and historically significant in its own right as a witness to late Platonism and concerns in later antiquity about the nature and foundations of what the astronomer knows and how he knows it.

PLANETARY RETROGRADATION: A REVIEW

To understand Simplicius' project in commenting on Aristotle's *De caelo*, the reader must first have a sure grasp of the phenomena of planetary station and retrogradation. Of course, how Simplicius understood these phenomena is different from how we do today. To begin, as most other Greek and Roman writers, he held that there were seven planets or wandering stars—the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn—each of which had two distinct, *real* motions about an Earth that was itself thought to be motionless at the center of the universe: a diurnal motion from east to west and a direct motion through the zodiacal constellations from west to east.⁶² Today, we know that the Moon is a satellite of the Earth, that Earth is a planet, and that all the planets—Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune—travel about the Sun. We also know that their diurnal motion is an *apparent* motion caused by the Earth's rotation from west to east about an axis inclined to the ecliptic plane that is defined by its direct (or, now *prograde*) motion from west to east about the Sun. Still, it is agreed that each planet has synodic planetary events and motions. What this means is that a particular planet's *phases* are to be understood in relation to its conjunction (*coniunctio*, σύνοδος) with the

⁶⁰ See, e.g., Neugebauer 1953; Maula 1974; Heglmeier 1996; Mendell 1998, 2000; and Yavetz 1998, 2001, 2003.

⁶¹ I have made this charge in earlier publications [see, e.g., Bowen 2001, 2002] and will substantiate it even more fully in the course of the following study.

⁶² For discussion of the ancient testimony concerning the views held by Heraclides of Pontus about the rotatory motion of the Earth and about the motions of Mercury and Venus around the Sun, see Todd and Bowen 2009 and Bowen and Todd 2009, respectively.

Sun and that the interval between consecutive phases of the same sort is constant and characteristic of each planet. For an outer or superior planet, that is, for a planet farther from the Sun than the Earth, there is conjunction when the Sun and the planet are on the same side of the Earth and, hence, are observed 'together'. These same planets are each said to be in opposition when the Earth intervenes and the observer sees the planet on the side opposite to the Sun [see Figure 1, p. 22]. Inner or inferior planets, in contrast, have two conjunctions and no opposition [see Figure 2, p. 22], precisely because the planet is closer to the Sun than the Earth—which obviously means that the Earth cannot ever come between the Sun and the planet.

For present purposes, the reader should bear in mind that

- the synodic periods of the planets range from 116 to 687 days,⁶³
- a planet is invisible to the naked eye when it is in conjunction with the Sun because it is lost in the Sun's light, and
- retrograde motion is an apparent synodic phenomenon observed before and after the inferior conjunction of an inner planet, and before and after the opposition of an outer planet.

Retrogradation itself is quite striking. During the course of its synodic period, each planet will to a northern observer on Earth making observations at regular intervals seem to cover less and less (angular) distance in its direct or prograde motion eastward through the zodiacal constellations until it actually appears to stop. This stopping is its first station. After an interval of several days or even of a few weeks, the planet will then seem to reverse itself and move back westwards covering increasing distances until once more it appears to slow down and then, again, to stop. This is its second station and the motion from first to second station is its retrograde motion. In the days after second station, the planet will seemingly reverse itself once more and gradually resume its motion eastward.

Retrogradation is an apparent, not a real, motion. Its explanation depends on whether the planet is inner or outer. If we simplify the configurations by supposing that the planetary orbits are circular and that they move in the same plane as that defined by the course of the Earth about the Sun (*scil.* the ecliptic plane), the inner planets will appear to move against the background of the fixed stars as shown in Figure 3 [p. 23]; and the outer planets, as shown in Figure 4 [p. 23].

⁶³ For the synodic periods of Mercury, Venus, Mars, Jupiter, and Saturn, see Comment 12.20, pp. 271–272. Those of Uranus and Neptune are 369.7 and 367.5 days, respectively.

To get a sense of what an observer north of the terrestrial equator may actually see, consider Figures 5 [p. 24] and 6 [p. 25]. The first shows the path of Venus' retrogradation during the months of October and November in 2010 when Venus was in the constellations of Virgo and Libra. The second plots the path of Mars in roughly the first half of 1997. It shows that Mars underwent retrograde motion during the months of February, March, and April while it was in the constellations of Virgo and Leo; and that this took place while Mars was north of the ecliptic plane. Indeed, as one can see, the path of Mars' orbit is oblique to the Earth's orbit (or the ecliptic), though only by a small amount ($1;54^\circ$).⁶⁴

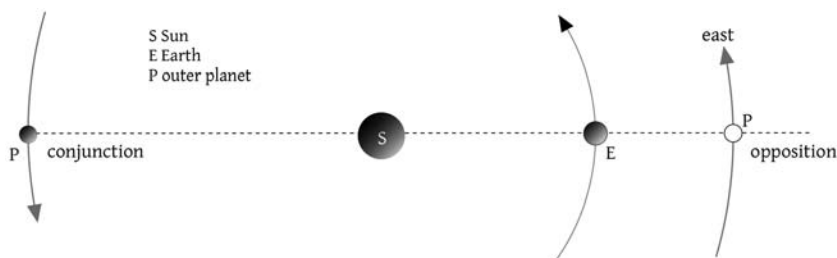


Figure 1. The conjunction and opposition of an outer planet with the Sun

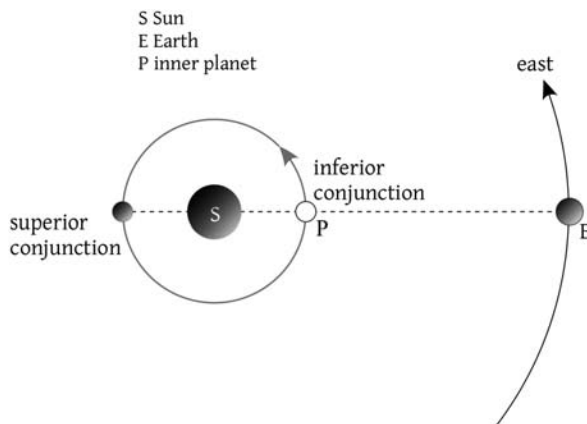


Figure 2. The conjunctions of an inner planet with the Sun

⁶⁴ In representing degrees, the semicolon serves to separate units and sixtieths; and commas, to separate sexagesimal places, that is, the first sixtieths or units of 60^{-1} , the second sixtieths or units of 60^{-2} , and so on, which are to the right of the semicolon.

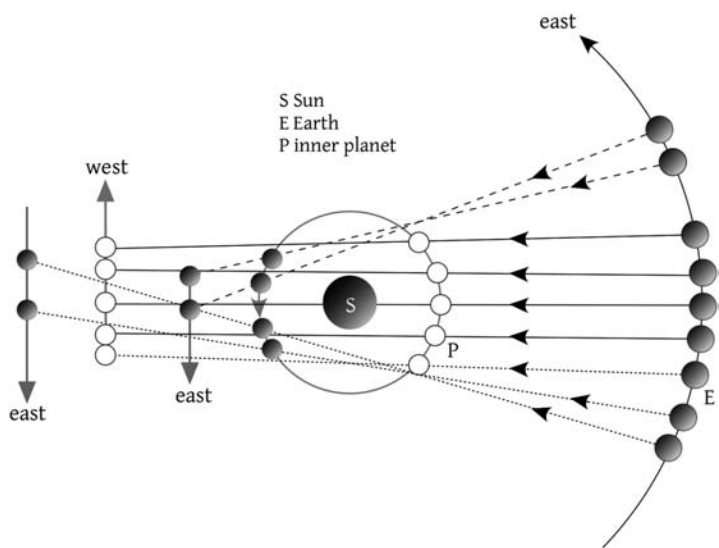


Figure 3. The retrogradation of an inner planet

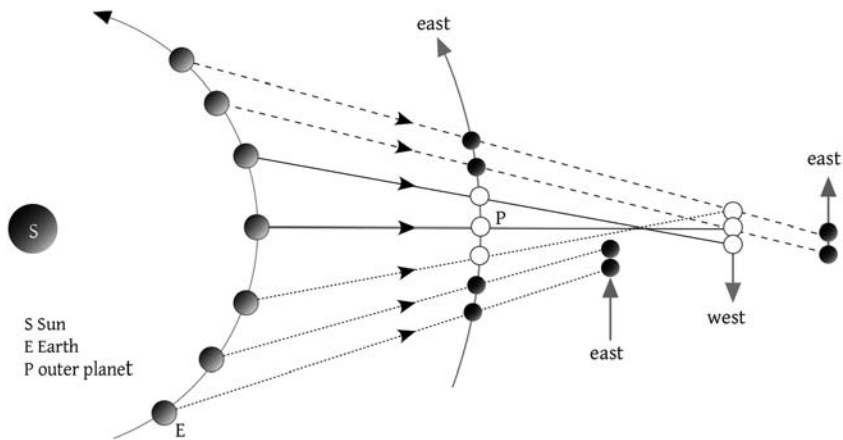


Figure 4. The retrogradation of an outer planet

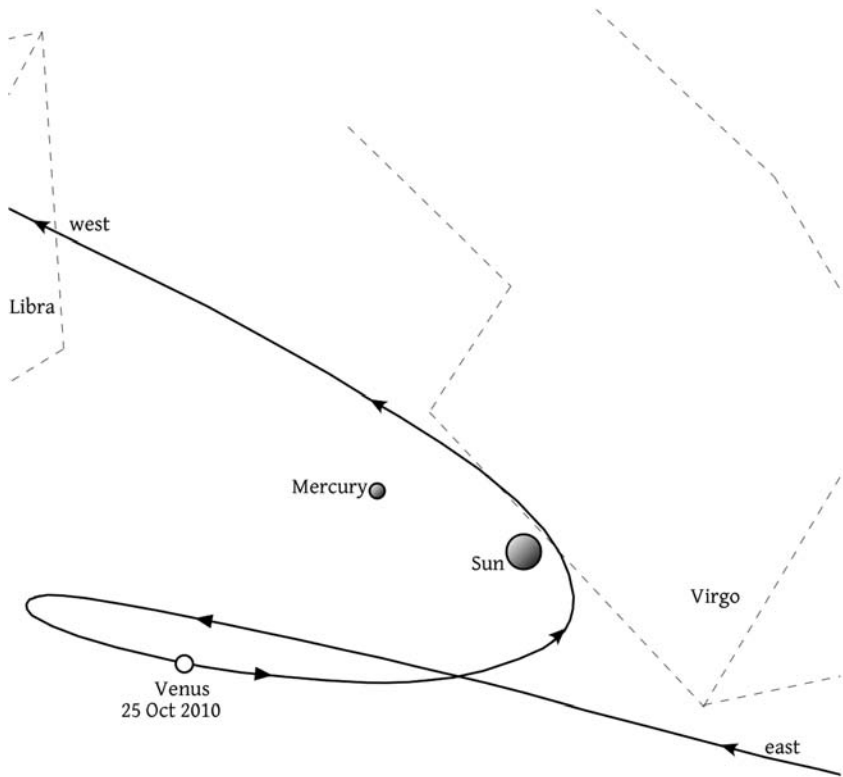


Figure 5. The retrogradation of Venus in 2010 plotted against the celestial sphere as seen from northern latitudes

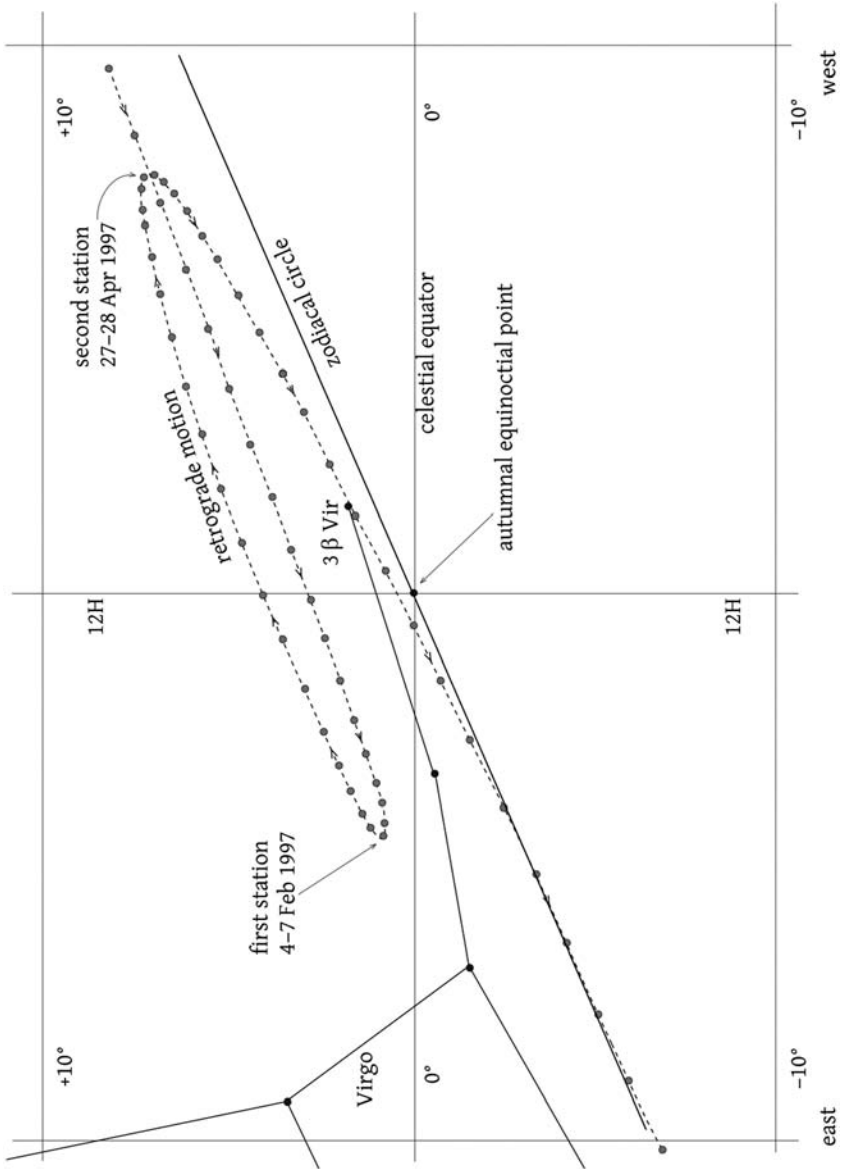


Figure 6. The retrogradation of Mars in 1997 plotted against the celestial sphere as seen from northern latitudes and marked in intervals of 4 days

CHAPTER ONE

THE HERESY OF
NON-HOMOCENTRIC AETHERIAL MOTION

The great digression at the end of Simplicius' *In de caelo* 2.12 [492.25–510.35] is an *apologia* precipitated by Philoponus, the renegade Platonist, and his attack on Aristotle's arguments for a fifth simple body, aether. The specific criticism [32.1–11] instigating this *apologia* begins by citing Alexander for the claim that, according to Aristotle, circular motion in the strict sense has to be about the center of the universe. By itself, Alexander's remark was surely meant to make sense of Aristotle's argument that, since there are but two simple motions—motion in a straight line and motion in a circle, the straight line and the circle being the only simple magnitudes—and given that each simple motion must belong to simple body by nature, there must, therefore, be a simple body the nature of which is to move in a circle, a body which Aristotle named aether. For, as Alexander apparently realized, this argument has little to commend it unless one gives proper weight both to the fact that the subject concerns *physical* bodies and magnitudes, and to the assertion that such bodies and magnitudes are intrinsically in motion from place to place, their nature being an internal source of this motion [*De caelo* 268b14–16: cf. 8.11–12]. Thus, when Aristotle maintains that there are but two simple physical magnitudes (the circle and the straight line), and infers that there can only be two simple locomotions, where motion in a circle is about a center and motion in a straight line is up and down, that is, motion to a center and from a center respectively [268b17–24], Alexander contributes the remark that the center in question has to be the center of the physical world or, in other words, the center of the totality of what there is.¹

But this creates a problem. As Philoponus remarks, none of the planetary bodies can, therefore, be said to move in a circle because, not only do they rotate about their own centers, they evidently have apogees and perigees—

¹ Cf. 14.27–29, 14.31–15.2, 15.22–31. See 10.28–11.30 for Simplicius' comment on *De caelo* 268b11–13, in which he locates the discussion in physical theory, that is, in philosophical reflection on the cosmos. See also 286n187.

a fact which, as he further notes, is inconsistent with Aristotle's planetary hypotheses [32.4–11].² This is, of course, but one thrust in Philoponus' attack on the late Platonist conviction that the universe is eternal. Yet it is a telling thrust. For Simplicius not only believes that the stellar bodies, both fixed and wandering, rotate about their axes, he too holds that the planets have apogees and perigees. Thus, to his chagrin, we may infer, this particular criticism brings to the fore two points against Aristotle in which he sides with Philoponus.³ The danger here is heresy: Simplicius is now obliged to show that his agreement with Philoponus does not entail Philoponus' blasphemous conclusion that the Craftsman God has fashioned a cosmos or universe akin to shoes and other human artifacts, all of which come to be at some time and then eventually perish [see 731.25–29].

In his immediate response, Simplicius counters with three assertions [32.12–32]:

- for Aristotle, circular motion in the strict sense was motion about *a* center, not necessarily the center of the universe;
- so far as Aristotle does say that it is about the center of the universe and even posits homocentric planetary hypotheses, he is following the hypotheses maintained in astronomy during his time; and
- Aristotle deserves no reproach for his homocentric planetary hypotheses, since all such hypotheses are but different answers to the question of how to save the phenomena.

But rather than develop his defense at this time, Simplicius deflects Philoponus with his own polemic to the effect that Philoponus has no good reason for holding that the stellar bodies rotate on their own axes [32.32–33.36]. Be that as it may, for his part, Simplicius can cite Plato as his authority [33.13–14]. As for Aristotle's views of how the heavenly bodies move, Simplicius proposes to take that up in commenting on *De caelo* 2 [cf. 33.14–16 with 11.7–10].

In point of fact, the question of the rotation of the heavenly bodies is reprised in *In de caelo* 2.8, when Simplicius undertakes to demonstrate that Aristotle agrees with Plato that all such bodies rotate about their own axes.

² See Comment 12.27, pp. 284–288 for an annotated translation of 32.12–33.16.

³ Cf. 32.32–34 and 32.34–33.13; 506.8–10.

AETHERIAL ROTATION

The critical locus is *De caelo* 290a7–24, in which Aristotle mounts a second argument that the stars (fixed and wandering) do not move of their own accord.⁴ He maintains that since the heavenly bodies are spherical, they must either rotate or roll if they move on their own, where rotation is circular motion in the same place and rolling is rotation combined with locomotion.⁵ Thus, given that the heavenly bodies should all perform the same motion by nature (in that they are made of the same stuff), that they are all observed to change place, and that only the Sun would appear to rotate, albeit only at its rising and setting, he infers that the heavenly bodies do not in fact rotate. As for the Sun's seeming to rotate, Aristotle explains this as a result of the fact that the Sun is observed at a great distance. As he says, 'When vision is extended over a great [distance], it dances about on account of its weakness' [290a17–18].⁶ Likewise, he would seem to imply, one should not infer that the heavenly bodies rotate because the fixed stars twinkle: their twinkling is due to the attenuation of our vision when it reaches them, though it is steady enough when it reaches the planets [290a18–24].⁷

Simplicius sets this out at greater length in 452.9–453.21. But then he asks:

But that there is twinkling too in the case of the Sun is manifest.⁸ Why then, one might ask, is rotation evident in the case of the Sun alone and not in that of the [bodies] beyond the Sun as well? When our vision is extended to these bodies, which are farther away, it should shake and quiver more on account of its weakness. [453.22–25]

He then cites (with approval, it seems) Alexander's answer to this question, an answer which includes an elaboration of what Aristotle meant in talking of extending vision a great distance [453.25–454.14]. Simplicius, having thus secured the possibility that the fixed stars rotate as the Sun does, now

⁴ See *De caelo* 289b1–290a7 for the first argument.

⁵ One the sense in which the planets and fixed stars are heavenly bodies, see Comment 10.02, pp. 201–202.

⁶ 290a17 ἐλίσσεται: though often rendered by 'rolls' [see, e.g., Mueller 2004a, 109], this is misleading. Note «κρδαινεται» at 290a22.

⁷ It is admittedly unclear whether these lines about the fixed stars and their twinkling is a direct contribution to the argument at hand (as I have construed them) or an aside meant only to elaborate the attenuation of vision by distance.

⁸ 453.22: Simplicius, unlike Alexander [cf. 453.25–34], would seem to suppose that what one observes in looking at the Sun as it rises or sets is the same as what one observes in looking at the fixed stars.

undertakes to explain away Aristotle's assertion that the planets do not twinkle, an assertion that conflicts *prima facie* with the view that the Sun is one of the planets and does twinkle.

This explanation advances on two fronts. In the first, Simplicius mitigates the apparent contradiction. As he sees it, in asserting that the planets do not twinkle, Aristotle may have been thinking of the five planets⁹ and, in any event, Aristotle made this claim with respect to what is predominately the case. In other words, Simplicius implies, he knew that the Sun twinkled but generalized with an eye to the other six that do not [454.15–18]. Such mitigation is supplemented by further remarks about Mercury's other name, «Στῖλβων» ('Twinkler') and the view held by some that Venus also twinkles, though Simplicius does allow that it might be better to explain such twinkling in terms of features specific to the two planets in question [454.18–22].

In the second, Simplicius gets to the point. He starts by addressing those 'who in vain contention separate Aristotle from Plato' on the ground that they disagree about the motion of the fixed stars—Plato writing that they rotate in place and are carried round by the heavens, and Aristotle denying that they rotate. Simplicius does not identify whom he has in mind but it is worthwhile to consider the question.

One possibility is that he is thinking of Alexander.¹⁰ But, more likely, I think, given his description of them as φιλονεικούντες [454.23], is that Simplicius means Philoponus and his fellow Christians. First, as we have seen, Simplicius agrees with Philoponus that each heavenly body rotates about an internal axis; and this agreement poses a problem in that Philoponus seeks to use the claim in the *De caelo* that the heavenly bodies do not rotate against Aristotle. Next, the verb «φιλονεικέω» and its cognates in the *In de caelo* is Simplicius' word of choice in describing Philoponus' criticisms of Aristotle. In fact, of its 19 occurrences in the *In de caelo*, all but four bear on Philoponus' polemic and they do this unkindly.¹¹

Granted, Simplicius has not mentioned Philoponus since his comments on *De caelo* 1.5. And so the question is, 'Why is Philoponus not named again

⁹ A standard grouping which is based on fact that unlike the Sun and Moon the other planets exhibit stations and retrogradations.

¹⁰ Cf. 377.20–34. See pp. 60–61.

¹¹ Hence, the primary sense of «φιλονεικέω» is 'engage in empty contention'. See 26.17–21, 70.16–19, 74.4–7, 87.29–88.2, 90.13–18, 143.9–17, 157.1–12 and 19–21, 164.21–23, 173.23–30, 178.26–28, 185.23–186.1: cf. 371.1–4 (of Christian criticism). The exceptions are at 65.9, 85.24–31, and 196.23–33.

but only alluded to here?’ The answer comes with reflection on Simplicius’ predicament. Philoponus’ other criticisms of Aristotle were dispatched directly and with some ease. It was, indeed, tactically useful to name him, thereby making him a clear target for abuse, because these criticisms did not involve any key elements that were also accepted by Simplicius and the late Platonists. But the criticisms concerning aetherial rotation and the homocentric planetary hypotheses were different because the premisses were in agreement on both sides.

It is interesting, then, that when he does address the difficulties posed by these two points of agreement, Simplicius addresses his readers, clearly his fellow Platonists [454.27–28, 510.31–34], thus revealing that these particular issues cut deeply and that his primary aim is to reassure the faithful.¹²

That there is an allusion at all to Philoponus at 454.24 is a mark of Simplicius’ confidence in his subsequent demonstration that the views of Plato and Aristotle are in accord, and that Aristotle did in fact hold that the heavenly bodies rotate. But if he could save Aristotle from Philoponus on this issue of aetherial rotation by a *proper* reading of what Aristotle has written, there was no such remedy for Aristotle’s adoption of homocentric planetary theory. And so there is no mention or comparable allusion to Philoponus when Simplicius eventually comes to that issue. Indeed, in the polemical context of the *In de caelo*, there would be nothing gained by explicitly accrediting Philoponus, a noisome distraction to the unwary in all other matters, any standing as a worthy opponent on such a delicate issue as the preference for non-homocentric planetary hypotheses. It would be hard enough to show his readers or fellow Platonists that in correcting Aristotle they do not follow Philoponus into heresy, that Aristotle’s error can be mitigated, and that their preference for more recent planetary hypotheses is to be understood in a way that preserves their faith and their way of life.

¹² In 509.16–510.8, when Simplicius reprises the question of aetherial rotation, he writes of Aristotle’s axiom (ἀξίωμα) or principle (λόγος) that circular motion is by definition motion about the center of the cosmos. Granted, he does unpack this to give its ‘proper’ meaning. But he is notably much less defensive here in presenting what Aristotle has written. This marks, I think, that his focus is on readers who are sympathetic and who, having read what has preceded, now understand the late Platonic interpretation of Aristotle in these matters. With them, there is no need to forestall criticism that seizes on surface meaning to show that Aristotle somehow missed the truth. Indeed, with them, one can even speak as though he had.

In fact, so delicate is the matter that, though the digression concluding *In de caelo* 2.12 is focused and organized as an *apologia*, Simplicius does even not draw attention to this explicitly. All he offers instead are the veiled remarks:

One should understand that this argument too advances as though in dependence on astronomical hypotheses bearing on turning [spheres] that are truly the case, although [these hypotheses] have no necessity, as I have also said earlier, since different [people] in fact saved the phenomena through different hypotheses. It would be appropriate for our accounts of the heavens and the heavenly motions to speak briefly about these hypotheses too, given that when they are hypothesized each [of their proponents] maintains that he saves the phenomena. [492.25–31]

Thus, while we give credence to Aristotle, we must follow more those who come later, on the grounds that they save the phenomena more [effectively] even if they do not save them completely ... [506.8–10]

Now, if this is more fitting to chapters about the heavens than to ones about first philosophy, none of us will criticize the rather lengthy digression from the [present] chapter, since it has come about at the right time. [510.31–34]

The actual demonstration that Plato and Aristotle maintain sidereal rotation need not detain us much longer beyond noting that Simplicius cites *Timaeus* 40a2–b8 to show that Plato does indeed suppose that each fixed star rotates about an internal axis [454.28–455.11] and then finds the same thesis in *De caelo* 290a7–24 (with a33–b11) [455.11–456.22]. In this way, he displays—or, one might better say, creates—an instance of that harmony of Plato and Aristotle which is a fundamental tenet of the late Platonic reading of these two thinkers. Moreover, it is also noteworthy that Simplicius concludes his defense of the thesis that the heavenly bodies rotate by adducing the authority of Ptolemy:

One should also pay attention to Ptolemy, the best of the astronomers, when he says in the second book of his *Hypotheses*:

Consequently, it is quite reasonable that, because this is both a capacity and an activity of theirs, each of the heavenly bodies moves, to be sure, in its own place, that is, [each moves] smoothly and in a circle back around its own center, since it is right that this [moving in its own place], which also secures [each heavenly body] in the structures containing it, belong to it first.¹³

¹³ 456.22–27. For a German translation of the Arabic version of this text, see Nix 1907, 131.9–15.

THE TASK REMAINING

I have argued that defending Aristotle against Philoponus' attack on homocentric planetary theory was, for Simplicius, of a very different order than warding off his attack on Aristotle's denial that each heavenly body rotates about an internal axis. Whereas the latter thrust could be parried by a 'proper' reading of Aristotle showing that there was in truth no such denial, there is no avoiding the fact that Aristotle propounds a false theory of planetary motion in *Meta.* A.8. Indeed, the challenge facing Simplicius was to show that *his* agreement with Philoponus on this point was not a heresy, that it did not in any way entail following Philoponus in inferring by *modus tollens* that the heavens are not made of aether and, therefore, that neither the heavens nor the cosmos are eternal.¹⁴ Such a conclusion was for him and his fellow Platonists shameless blasphemy and irrational.¹⁵

To counter Philoponus' attack, then, Simplicius mounts a complex *apologia* with three interlocking aims. First, he seeks to mitigate Aristotle's error in a manner that preserves Aristotle's authority, that is, his standing as the most genuine or truest student of Plato [378.20–21: cf. 26.22–25], who is himself the prophet of the Craftsman God [106.4–6]. At the same time, Simplicius also tries to uphold the validity of the cosmology expounded in the *De caelo* and, thus, its authority as a sacred text in the late Platonic program of education. Finally, he endeavors to palliate the late Platonist preference for epicyclic and eccentric planetary hypotheses by showing that such deviation from Aristotle does not make them heretical and apostate; rather, it marks them as his faithful followers and as devotees of the divine truth [26.11–15, 377.29–34].¹⁶

In Chapters 2–4, I will show how this is accomplished. Chapter 2 explains Simplicius' view of astronomical hypotheses in general, a view foundational to the *apologia*. Chapter 3 details the *apologia* itself; and Chapter 4 looks to how Simplicius uses past literature to construct and supplement his *apologia*. But first I will conclude the present chapter with a thumbnail account of Simplicius' own account of the heavens and their motions.

¹⁴ On Philoponus' aim, see 34.5–7, 35.31–33, 50.15–18 (with 731.25–29), 80.23–26, 81.10–11, 119.7–13.

¹⁵ Cf. 25.22–26.17 and 26.28–31 (with pp. 12–13), 35.33–35, 70.17–18, 135.9–10, 731.25–29 (the concluding prayer, with p. 10).

¹⁶ See p. 60.

SIMPLICIUS ON THE HEAVENS

Simplicius would, of course, maintain that his own understanding of the heavens is not only to be found in Plato's writings, it also underlies Aristotle's teachings. And yes, he would, in our view, be in error about this: but that has no bearing now, if we are to discern the predicament into which Philoponus' criticism at 32.1–11 puts Simplicius. For this, we must try to understand the criticism *as* Simplicius saw it. The following outline, then, is limited to those aspects of Simplicius' interpretation of Aristotle and Plato which are brought to bear on the account of the heavenly bodies and their motions in his *apologia*.

To begin, for Simplicius, Aristotle's fifth simple body, aether, is a blend of the purest forms of each of the four sublunary elements (earth, water, air, fire), that is, of fire in the sense of what shines, of earth in the sense of what is resistant to sensation, and of the intermediates as what is purely intermediate [12.29–31: cf. 16.18–26].¹⁷ This blend is unlike and irreducible to any of the sublunary simple bodies. In it, fire *qua* light predominates and thus gives this simple body its primary attribute [17.20–33], visibility. It is the nature of aether to move in circle about *a* center. Since there is no motion contrary to circular motion, there is no simple body that is opposite to aether; hence, aether is free of the variety of mutation that governs the sublunary simple bodies and their composites. Indeed, since it cannot come into being or perish, aether is eternal¹⁸ (and with it, the cosmos).

All aetherial bodies are spherical and rotate about an internal axis. Some of these bodies are carried around in other aetherial bodies which rotate about other centers. The non-wandering or fixed stars are attached to a single sphere that rotates about the center of the cosmos. The seven wandering stars or planets are carried round in more complex systems containing at least one rotatory motion that is not about the center of the cosmos. These systems, however, are embedded in aetherial, spherical shells which do rotate about the center of the cosmos.¹⁹ These systems are, in turn, nested in a single complex [cf. 474.21–28].²⁰

The planets understood as systems are ensouled and rational, and, hence, capable of action. Indeed, though aether moves by nature in a circle, this is

¹⁷ See 12.16–27 for Simplicius' contention that Plato posited a fifth simple body which he called fire meaning light, since he held that light was a form of fire.

¹⁸ See 84.11–85.15, where these claims about aether are 'found' in Plato's *Timaeus*.

¹⁹ Cf. Figures 12.13 and 12.14, pp. 196–197.

²⁰ See Comment 10.13, pp. 211–213. See also Figure 7, p. 35.

6 PRIMA PARS COSMOGRAPH.

Schema prædictæ diuisionis.



Figure 7. Nested spherical shells [Apianus 1584]

by itself insufficient to explain planetary motion. For that, one must grant that the direction and speed in which a planet moves are matters of its choosing what is best for the cosmos [472.8–15, 473.1–6: cf. 488.30–489.4]. What we see in the heavens, then, is the outcome of choices by divine, rational animals, where each choice is a deliberate blending of the natural motions in different directions of the rotating spheres constituting each planet's body [473.6–474.6].²¹

The cosmos or, more specifically, the celestial sphere, is a hypostasis or substantive existence that derives from the Craftsman God. It too is a rational animal, one that comprehends within itself undifferentiated all celestial motions, in particular, the motion eastward and the motion westward.²² Its 'creation' is *before* time and, thus, does not impinge on the fact that the body of this sphere is immune to generation and corruption and, hence, eternal. The planets themselves are each hypostases of the celestial sphere [473.8–474.1]: the blending of the motions in the nature of each planetary animal shows its kinship to the celestial sphere, a kinship that decreases with distance from that sphere.

²¹ See Comment 10.12, pp. 210–211.

²² See 487.4–10 with 487.15–488.1, 490.6–16.

CHAPTER TWO

THE HERETICAL REJECTION OF ALL HYPOTHESES

Simplicius' excuse for following more recent theorists and not Aristotle in matters concerning the motions of the heavenly bodies comes with a brief and easily overlooked caveat—namely, that *none* of the astronomical hypotheses currently in play has any necessity (ἀνάγκη) [488.25–27, 492.25–28, 502.2–3]. In other words, as Simplicius says, though each hypothesis distinguishes appearance and reality and then posits a state of affairs enabling one to 'save' or account for the phenomena, none of the hypotheses is demonstrably true (ἀληθές, κατ' ἀλήθειαν). Rather, for him, the true account (ὁ ἀληθὴς λόγος) neither admits the apparent planetary motions as real nor utilizes hypotheses; instead, it reasons on the basis of duly established physical theory that the planets move with motions that are simple, smooth, circular, and ordered [488.10–14], (real) motions which presumably enable one to account for the motions observed.¹

This caveat, with its strong affirmation of a non-hypothetical account of the celestial motions, seemingly undercuts Simplicius' *apologia* in its entirety and puts into question the very point of commenting on the *De caelo*. After all, why settle for the Ptolemaic account when it, like the homocentric theory as propounded by Aristotle, lacks proper warrant and cannot be said to be true? If neither is true, is the choice of one over the other really defensible? Further, given that the very goal of the *De caelo* is to demonstrate the fundamental heavenly motions on the basis of a properly established physical theory, why study this cosmological tract if its physical theory licenses an account of the celestial motions which is inadequate and thus, contrary to its intention, merely a hypothesis and not a good one at that?

This caveat would thus seem to entail an even more radical heresy. The puzzle, then, is that Simplicius simply makes this criticism, argues that adherence to the Ptolemaic hypotheses can accommodate the broad argument of *De caelo* 2.12, and closes his digression with the remark:

¹ This is in part what lies behind his remark at 32.29–32 that differing about planetary hypotheses is not a matter of reproach, since each is at best consistent with the phenomena. See Comment 12.27, pp. 284–288.

Now, if this is more fitting to chapters about the heavens than to ones about first philosophy, none of us will criticize the rather lengthy digression from the [present] chapter, since it has come about at the right time. But we must return to what comes next in Aristotle's chapters. [510.31–35]

Granted, Aristotle himself admits that inquiry about the heavens is difficult. But at no point does he allow that one is therefore permitted to take a position concerning their motions that is unwarranted by argument. Yet Simplicius fails to provide an argument of his own or to show that there is in fact one implicit in the works of Plato and Aristotle.

One might well be tempted to conclude that Simplicius is truly idiotic and abandon him with dark thoughts about cultures of reading and how they can thwart that impulse to understand which they are meant to serve. But patience will, in this instance, vindicate Simplicius. As I will argue, there are in his commentaries on the *Physica* and *De caelo* several considerations that warrant his leaving unexamined the question of the physical theory required to make due sense of the planetary motions.

SIMPLICIUS, *IN PHYS.* 2.2 193B22–35

To begin our own *apologia* on Simplicius' behalf, we should clarify what astronomical hypotheses are for him and how they figure in the science of the heavens. This means turning attention to a passage in the commentary on *Phys.* 2.2, a passage in which Simplicius not only elaborates what hypotheses are but also brings to the fore more urgently the need for an unhypothetical account of the planetary motions.²

Aristotle on Physical Theory and Mathematical Science

The lemma at issue is *Phys.* 2.2 193b22–35, a text in which Aristotle writes briefly about the distinction between physical theorists (ὁ φυσικός) and certain scientists (ὁ μαθηματικός), that is, between philosophers engaged in the study of Nature (φύσις) and non-philosophers who also study Nature but characteristically with the help of mathematics.³

² Simplicius' commentary compares very interestingly with Philoponus' remarks on the same passage [Vitelli 1887–1888, 218.19–223.29]. (Philoponus' commentary was written around AD 517: see Golitsis 2008, 22–37, which includes criticism of Verrycken's contention that it was revised after 529.) It is worth noting that Philoponus does not broach the subject of astronomical hypothesis.

³ 290.3: the definite article here is generic in sense (that is, it refers to any member of the

Simplicius' comment opens with a paraphrase. As he says, Aristotle reasonably wants to distinguish physical theorists and mathematical scientists because they all seem concerned with the same things. Indeed, in that physical theorists study physical bodies which necessarily have vertices, lines, surfaces, and shapes—the very things that mathematical scientists study—it would follow that mathematical science (ἡ μαθηματική) is part of philosophy *qua* physical theory.⁴ Likewise, he says, Aristotle distinguishes astronomy (ἀστρολογία) and physical theory since they share concerns too—both astronomers (ὁ ἀστρολόγος) and physical theorists study bodies in motion (rather than bodies that cannot be moved, as geometers do) and so speak about the same things. For, even if physical theorists typically focus on the substance of these moving bodies and mathematical scientists limit attention to the incidental, quantitative features of these motions, it would be absurd to suppose that physical theorists do not talk of motions as well.⁵ So, Simplicius suggests, it would seem that, since physical theorists address both the substance and the incidental features of the heavenly bodies, while astronomers consider only the latter, astronomy is a part of physical theory. In this way, mathematical science and, specifically, astronomy, would be closely related (σύνεγγυς) to physical theory—which is why it was necessary to distinguish them.⁶

After explaining that mathematical science is *not* part of philosophy *qua* physical theory,⁷ Simplicius then undertakes to show that astronomy (in particular) is not one either. The difference, so he says, lies in the fact that, when astronomers consider the heavenly bodies, they too do not treat them *qua* physical by focusing on what belongs to them intrinsically; rather,

class, or to the class collectively) and will be translated consistently in the plural form. See 43n22 below. On the meaning of «ὁ μαθηματικός», see Comment 10.04, pp. 203–204.

⁴ Diels 1882–1895, 290.3–9.

⁵ 290.14 ὁ μαθηματικός: in context, this ought to be «ἀστρολόγος», since Simplicius has designated the practitioners of ἀστρολογία as ἀστρολόγοι. The problem is one of Simplicius' own making: Aristotle does not use the word «ἀστρολόγος» but speaks only of the μαθηματικός in *Phys.* 193b22–35. The issue here need not be wholly terminological, but it may reflect a difference in the social and intellectual awareness of astronomy as a discipline or profession. Cf. Diels 1882–1895, 293.7–15.

⁶ 290.9–26.

⁷ 290.27–291.7. As Simplicius explains, the physical theorist, unlike the mathematical scientist, talks of the matter that physical bodies have in addition to their properties. Moreover, when the physical theorist discusses these properties, he construes them as properties of physical bodies, whereas the mathematical scientist treats the properties as though they existed on their own. That is, unlike the physical theorist, the mathematical scientist separates these properties in thought from the bodies to which they belong.

they view them as moving bodies exhibiting configurations and ignore any intrinsic connection that these configurations might have to the bodies themselves. Thus, physical theorists argue that the heavenly bodies are spherical because of all the shapes that bodies may have, this one alone is primary, simple, complete, uniform and, therefore, appropriate to the first body. Astronomers, however, argue to the same conclusion from the fact that the sphere is more capacious than any other solid with the same perimeter.⁸

Physical Theory and Astronomy Recast

But this is clearly insufficient for Simplicius. After all, the preceding characterization of astronomy with its example of an astronomical argument for the sphericity of the heavenly bodies would undoubtedly seem antiquated and curiously out of touch in the sixth century AD. For, though his physical theory was resolutely rooted in the fourth century BC, astronomy in Simplicius' time was a muscular science replete with geometrical argument; moreover, its leading edge was planetary theory, the defining characteristic of which was the use of hypotheses and the production of numerical tables.⁹ Further, and perhaps just as important, was the fact that *Phys.* 2.2 provided a fitting occasion to address something lacking in *In de caelo* 2.12, a detailed explication of what Simplicius understood by an astronomical hypothesis.¹⁰ And so, immediately after remarking that

in this way Aristotle has pointed out in a few words the difference of physical theory in relation to science and astronomy, [Diels 1882–1895, 291.18–20]

Simplicius updates this account by citing Alexander:¹¹

⁸ 291.7–20.

⁹ Recall the commentaries written in Alexandria of the fourth century AD by Theon on Ptolemy's *Almagest* and *Canones manuales* [see Watts 2006, 187–188, 191–192] and by Pappus on the *Almagest*, along with book 6 of Pappus' *Collectio* and Proclus' own treatise outlining the planetary hypotheses developed in the *Almagest*.

¹⁰ While Simplicius' *In phys.* was written *after* the *In de caelo*, it was in fact meant to be read before it. Indeed, it would seem a reasonable working hypothesis that Philoponus' attack on Aristotle and the exigencies of replying to it were factors that figured importantly in determining the order in which Simplicius wrote his commentaries.

¹¹ Though there may be instances in which Simplicius' comments on a lemma are motivated by a desire for magisterial completeness [see Baltussen 2008, 22, 122, 205–207], Simplicius continues here, I think, because the distinction made by Aristotle is problematic as it stands.

[F18.1] Alexander [of Aphrodisias] assiduously¹² quotes a certain text of Geminus, derived from [the latter's] epitome expounding Posidonius' *Meteorologica*¹³—[a text] that takes its starting points from Aristotle. It goes as follows:

It is for physical theory to inquire into the substance of the heavens and of the heavenly bodies, into their power and quality, and into their coming into existence and destruction. Through these [investigations],¹⁴ it can certainly offer demonstrations concerning size, shape, and ordering. Astronomy, on the other hand, does not attempt to speak about anything of that sort. Instead, it demonstrates the order of the celestial [bodies] after declaring that the heavens really are a cosmos, and speaks about the shapes, sizes, and distances of the Earth, the Sun, and the Moon, about the eclipses and conjunctions of heavenly bodies, and about quality and quantity in their movements. [F18.5]

It follows that since astronomy deals with the theory of quantity, duration, and type of shape, it is reasonable for it to need arithmetic and geometry for this. And concerning these matters, which are the only ones about which it undertakes to supply an account, it has the authority to make inferences through arithmetic and geometry. [F18.10]

[Kidd 1988–1999, 18.1–18 ~Diels 1882–1895, 291.21–292.3]

¹² Kidd 1988–1999, F18.1 ~Diels 1882–1895, 291.22 φιλοπόνως. See 11138.

¹³ F18.2 ~Diels 1882–1895, 291.22: reading «τῆς» (conjectured by Diels) after «ἐπιτομή»; i.e., this is Geminus' epitome of Posidonius' treatise. On Geminus' date, see Bowen 2006, 199n4 or, for a different line of argument to the same conclusion, Evans and Berggren 2006, 15–22.

Evans and Berggren [2006, 4 and 250n1] follow Jones [1999, 255] in speculating that Simplicius is giving the actual title of that work, namely, *Concise Exposition of the Meteorology of Posidonius*. This is possible but hardly necessary given Simplicius' Greek. Moreover, one should note that Priscian [Kidd 1988–1999, T72] calls the work a *commentum* (commentary), not an epitome; and Ian Kidd in his commentary on T72 [1988–1999, 2.57] confidently maintains that Priscian mentions 'Geminus' *Commentary on Posidonius' Meteorology*' (Kidd's italics).

As for the Posidonius treatise itself, it would appear that Alexander and Simplicius identified it as a work entitled «Μετεωρολογικά», a title which Simplicius may have intended to mean 'Matters pertaining to the Heavens'. No such title is attributed elsewhere to Posidonius (ca 135–ca 51 BC), while Priscian [Kidd 1988–1999, T72] refers to a commentary by Geminus on a Posidonius work called «Μετέωρα». Kidd [1988–1999, 2.129] refers to it as a 'somewhat general title', and it is queried in the heading for F18 [1988–1999, 2.44]. Since F18 is markedly synoptic and its subject matter closely resembles that deployed in the preliminary classification in Diogenes Laertius' survey of Stoic physics at *Vitae* 7.132–133 [see Kidd 1988–1999, 2.406], it may originally have been part of the preface to one of the works of Posidonius bearing a similar title, perhaps the *Μετεωρολογική (στοιχείωσις)* [Kidd 1988–1999, F14–15] rather than the *Περὶ μετεώρων* [Kidd 1988–1999, F16–17].

In what follows I will speak of Alexander's source as Posidonius/Geminus to forestall the question of Geminus' contribution [see Bowen 2007, 330–331]. Simplicius, for his part, seems confident that the substance of this citation goes back to Posidonius [F18.50–53 ~Diels 1882–1895, 292.29–31].

¹⁴ F18.7 ~Diels 1882–1895, 291.25: reading «νῇ διὰ τούτων» with Bake.

This distinction between physical theory and astronomy is now made by way of a fuller description of their subject matters. Physical theory focuses on the essential nature and qualitative aspects of the heavens and the bodies in them; whereas astronomy focuses on their quantitative aspects, which is why it accordingly relies heavily on arithmetical and geometrical argument. The report continues by elaborating a point already made several times—that astronomy and physical theory often treat the same topics, e.g., the shape, size, and order of the heavenly bodies—and by drawing attention to the differences in their procedures.

- [F18.20] Now astronomers and physical theorists¹⁵ will in many cases propose demonstrating essentially the same [thesis] (e.g., that the Sun is large, that the Earth is spherical), yet they will not follow the same procedures.¹⁶ For, whereas [physical theorists] will make each of their demonstrations on the basis of substance, or power, or ‘that it is better that it be thus’, or [the processes] of coming into existence and change,¹⁷ astronomers [will do so] on the basis of the [properties] incidental to shapes or to sizes, or on the basis of the quantity of motion and of the time interval appropriate to it.¹⁸
- [F18.25]

Also, physical theorists will in many cases deal with the cause by focusing on the causative power,¹⁹ whereas astronomers, since they make their demonstrations on the basis of extrinsic incidental properties,²⁰ are not adequate observers of the cause in explaining that the Earth or the heavenly bodies are spherical, for example. Sometimes they do not even aim to comprehend the cause, as when they discourse on an eclipse.²¹

¹⁵ F18.19 ~Diels 1882–1895, 292.4 ὁ τε ἀστρολόγος καὶ ὁ φυσικός.

¹⁶ F18.21 ~Diels 1882–1895, 292.4 ὁδοῦς.

¹⁷ Thus, for example, given the premiss that every one of its parts moves by nature to the center of the cosmos, Aristotle, [*De caelo* 2.14 297a8–b23] demonstrates that the Earth is spherical. Cf. Cleomedes’ argument that the cosmos is spherical at Todd 1990, 1.5.126–145 [with Bowen and Todd 2004, 72–73].

¹⁸ Aristotle [*De caelo* 297b23–298a8] argues that the Earth is spherical on the basis of such perceptual evidence as the appearance of the Moon during a lunar eclipse [see Comment 11.03, pp. 219–220] and the variation of the night sky as one moves north and south. Cf. Todd 1990, 1.5.1–125 [with Bowen and Todd 2004, 63–72; Bowen 2003c, 60–62].

¹⁹ F18.26 ~Diels 1882–1895, 292.10 ποιητικὴ δύναμις.

²⁰ F18.27 ~Diels 1882–1895, 292.11 ἀπὸ τῶν ἐξωθεν συμβεβηκότων: cf. F18.23–24.

²¹ See Todd 1990, 2.4.95–107 [with Bowen and Todd 2004, 2.4 nn8, 19] on the Posidonian physical theory underlying eclipses. Mueller [2004b, 69] claims that the mention of eclipses shows that a special notion of causation is at issue, since, as he says,

it is hard to imagine that any astronomer or physicist ... living after, say 400, would have discussed solar or lunar eclipses without mentioning as an explanation the interposition of the moon between the sun and the earth or of the earth between the

[F18.30] At other times [astronomers]²² make determinations in accordance with a hypothesis²³ by setting out some modes [of accounting for the phenomena]; and, if these are the case, the phenomena will be saved.²⁴

This section of Simplicius' report casts light on the relation of physical theory and astronomy. In F18.18–30, it effectively distinguishes two forms of explanation: the causal, demonstrative accounts offered by physical theorists and the non-causal, demonstrative accounts offered by astronomers. The former accounts are plainly assigned a higher cognitive worth. After

moon and sun, the latter being a well-known Aristotelian example of scientific causal explanation.

Mueller suggests that Posidonius/Geminus discounts the astronomer's geometrical models as really explanatory because the alleged cause is not better known than the effect. I suspect, however, that it may be a mistake to assume that, for Posidonius/Geminus, eclipses were to be explained simply by the interposition of celestial bodies.

The problem is that by the first century BC, this may not have been good enough. Posidonius/Geminus may have deemed it important that not only are there species of eclipses (total and partial) but that eclipses are also periodic [cf. Bowen and Goldstein 1996 on Geminus, *Intro. ast.* 18.1 (the *exeligmos*)]. But giving a proper causal explanation of eclipses so understood would require going beyond Aristotle by accounting for the occurrence of the various species of lunar and solar eclipse as well as for the periodicity of their occurrences. Further, such an account would necessarily lie outside astronomy, since it can at best quantify the periods involved.

Note that Geminus *describes* when solar and lunar eclipses occur in *Intro. ast.* cc. 10–11 without using the language of causation except when drawing inferences from his description. Likewise, in 1.31–41, Geminus demonstrates that the Sun's smooth motion along an eccentric circle has the necessary consequence that the Sun appears to traverse equal arcs of the zodiacal circle in unequal times, without saying that this eccentric solar motion is a cause.

²² F18.30–32 ~Diels 1882–1895, 292.13–15; the subject is «ὁ ἀστρολόγος». Taking the definite article as generic and construing the subject as the class of astronomers or 'any astronomer' [see 38n3] avoids attributing to Posidonius/Geminus the claim that a given astronomer will commit to more than one hypothesis at a given time [see below].

²³ At Todd 1990, 2.1.310–311 and 332–333 similar language is used in connection with premises in a calculation of the size of the Sun. There, the hypotheses are assumptions made within the context of a larger argument; here, they are foundational to the argument itself.

²⁴ Kidd 1988–1999, F18.18–32 ~Diels 1882–1895, 292.3–15. F18.31 ~Diels 1882–1895, 292.14 τρόπους τινάς.

Evans and Berggren [2006, 254] misconstrue the syntax of this sentence. Moreover, by adopting too narrow a notion of the intellectual context of this passage, they overlook the fact that the term «τρόποι» had significance in contemporary philosophy [see 46n29], and that the passage does indeed make sense if the occurrences of «τρόποι» at lines F18.31, and 38 are translated in the same way, rather than by 'devices' and 'way', respectively (or by 'conditions' and 'method' [so Mueller 2004a, 69]). Indeed, a 'mode or way [of accounting for the phenomena]' [cf. 'supply an account' («λῶγον ἀποδῶσσειν») at F18.17] is the adaptation of a single hypothesis to account for the same phenomena in specific sets of circumstances. Thus, for example, a phenomenon common to several objects, such as the first morning appearance of an outer planet, might be accounted for on the basis of an epicyclic hypothesis that is quantified differently for Mars, Jupiter, and Saturn.

all, the physical theorist, by arguing in terms of the intrinsic properties of some celestial object, secures knowledge of the object itself and explains *why* something is as it is. In contrast, the astronomer, by arguing in terms of the extrinsic properties of the same object, can show only *that* the thing is as it is.²⁵

F18.30–32 makes an important addition by affirming that even non-causal accounts offered on the basis of hypotheses, rather than on the basis of some (known) extrinsic properties of a celestial object, may still save the phenomena if the hypotheses prove to be the case (or true).

The text itself is unmistakeable on this. In the conditional ‘if these are the case, the phenomena will be saved’ («ὧν ὑπαρχόντων, σωθήσεται τὰ φαινόμενα»), the antecedent of «ὧν» in the protasis «ὧν ὑπαρχόντων», a genitive absolute, is «τρόπους τινάς» (‘some modes [of accounting for the phenomena]’) in F18.31. Moreover, the apodosis contains a future indicative. It identifies not the ways in which the phenomena might be saved (ἂν σωθῇ would be the Greek in that case), but the ways in which they will in fact be explained and thus saved.

In sum, the force of «ὑπαρχόντων» is that the applications of the hypothesis in the various modes of demonstrative explanation are the case, not just that they successfully account for the phenomena. That is, the modes must not only be logically valid arguments, they must be sound if they are to save the phenomena. But, to repeat, this is possible *only* if the hypothesis which these modes apply is in fact true as well.

But this raises an obvious question: ‘Who is concerned with the truth of such hypotheses—the astronomer, or the physical theorist, or both?’ The clear implication is that both are: the physical theorist, because he is concerned with the *realia* by profession; and the astronomer, because, though he cannot demonstrate this, he still wants to claim that a given hypothe-

²⁵ Cf. Aristotle, *An. post.* 76a4–13, 78b34–39: the latter passage subordinates accounts explaining *that* something is the case (ὅτι) to those explaining *why* it is the case (διότι).

Diogenes Laertius, in his book on the Stoic Zeno of Citium, asserts [*Vitae* 7.132–133] that both scientists (οἱ ἀπὸ τῶν μαθημάτων) and physical theorists study the cosmos but differ in the particular subjects of their inquiries. After describing this difference in much the same way as Simplicius reports, he then indicates that there is a similar difference in the sorts of causal explanation (ὁ αἰτιόλογος λόγος) that they offer. It is interesting that in describing the explanations offered by the scientists, Diogenes does not cite astronomical *explananda* specifically but only vision and images in a mirror, as well as clouds, thunder, rainbows, halos, and comets; and he maintains that the explanations offered are causal. For the view that explanations in optics are not causal, a view that acknowledges its dependence on Posidonius and seems to draw on what Simplicius reports of Posidonius/Geminus, see Seneca, *Ep.* 88.26 with Bowen 2009.

sis does indeed *save* the phenomena. Thus, while the astronomers being envisaged may collectively, or even individually, have known a number of hypotheses by which to account for the same astronomical phenomena, the assumption *in this report* appears to be that each astronomer will offer only one hypothesis in doing this, since, after all, only one of them can be actually the case.²⁶

One may, of course, debate whether such a realist interpretation of astronomical hypothesizing is credible, and whether it is a decent characterization of the typical practice and attitudes of astronomers of the time. Specifically, one may challenge the claim that, when an ancient astronomer says that a hypothesis saves the phenomena, he is committed to its actually being the case, though, of course, *qua* astronomer he cannot demonstrate that. This claim does have a certain plausibility *prima facie*, however. For, even if astronomers were not really interested in offering non-causal accounts *per se*, and regardless of their being troubled or untroubled by competing hypotheses in accounting for given phenomena, each did, so far as we know, settle on a single hypothesis in devising any given table quantifying these phenomena.

In any event, this claim is essential to the view expressed subsequently that the astronomer must take the starting points of his demonstrations from the physical theorist. For Posidonius/Geminus, the dependence of astronomy on physical theory is intrinsic to astronomy itself because physical theory is knowledge of the *realia* exhibiting the extrinsic properties studied by astronomers, and because astronomers wish to make claims about how things are. That is, this dependence is rooted in the fact that, when astronomers assert that they can save phenomena using a given hypothesis, they mean (or must be understood to mean) that this hypothesis is the case or true.

At this point, Simplicius' report begins to show its curious history; and we have the first of two dislocations marking ellipses that may be the result of

²⁶ See 42n15, 43n22 above. The possibility of competing multiple explanations all of equal cognitive worth was a philosophical construct, acceptable in qualified form to the Epicureans [see Asmis 1984, 321–330], but rejected here and easily exploited by a Sceptic [see 46n29]. But see G.E.R. Lloyd 1991, 267 in which it is claimed that, for *Geminus*, 'it is his (*scil.* the astronomer's) business to say in how many ways it is possible to save the phenomena' [cf. Mueller 2004b, 74–75]. In Simplicius' report [cf. Bowen and Todd 2004, 197n8], however, that astronomers produce a number of hypotheses would seem to be an inevitable consequence of the fact that each astronomer tries to save the phenomena but lacks the means to *demonstrate* that his hypothesis is true rather than just consistent with the relevant phenomena.

the way in which texts have been excerpted, summarized, expounded, and quoted. The reader, though initially promised an example of the preceding account of astronomical procedure, is suddenly confronted with a question that appears to have very serious consequences.

[F18.35] For example: ‘Why do the Sun, the Moon, and the planets appear to move unsmoothly?’ Because whether we hypothesize²⁷ that their circuits are eccentric, or that the celestial bodies go round along epicycles, their apparent unsmoothness [in motion] will be saved.²⁸ And [we] will have to go through *all* the modes according to which these phenomena can be caused, so that our systematic treatment²⁹ of the wandering stars will look like a causal theory [set out] according to each possible mode [of causation].³⁰

²⁷ F18.33–34 ~Diels 1882–1895, 292.16 ὅτι εἰ ὑποθώμεθα: the ὅτι-clause indicates why the question is being asked. The first-person plural subject of this verb is maintained in the rest of this paragraph [as also by Heath 1913, 276]. For the argument that the ‘we’ involved here are Stoics, or Posidonius/Geminus and an audience of fellow Stoics, see Todd and Bowen 2009, 175–180. Kidd [1988–1999, 3.80], however, writes ‘their’ before «πραγματεία», and sees this as a description of astronomical practice and not as one of the consequences of its malpractice, as argued at Bowen and Todd 2004, 195–198.

²⁸ F18.33–35 ~Diels 1882–1895, 292.16–18: the eccentric and epicyclic hypotheses are treated here as independent rather than equivalent. No extant Greek or Latin writer of the first centuries BC and AD mentions this equivalence; those that do consider the planetary motions choose one hypothesis or the other, not both. On saving the phenomena before Ptolemy, see Comment 12.09, 251–259.

Theon of Smyrna reports that Adrastus of Aphrodisias (late first or early second century AD) [T.H. Martin 1849, 74–75] was the first to show that the eccentric hypothesis follows incidentally (κατὰ συμβεβηκός) from the epicyclic hypothesis, but then claims for himself the proof that the epicyclic hypothesis follows from the eccentric hypothesis [Hiller 1878, 166.10–13]. On the value of such reports when they cannot be confirmed, see Bowen 2002.

Ptolemy suggests the possible equivalence of the two hypotheses at *Alm.* 3.3 [cf. Toomer 1984, 144 n32] but does not discuss it until *Alm.* 12.1. On the strength of the latter text, some modern scholars [see, e.g., Neugebauer 1955, 1959] suppose that the proof of this equivalence goes back to Apollonius of Perga (third century BC). But see Comment 12.07, pp. 244–247.

Alexander Jones has kindly pointed out to me that papyrus PSI inv. 515 (= PSI XV 1490) (very early second century AD, perhaps part of a larger treatise [see Jones 2004]) mentions an eccentric and an epicyclic model for solar motion and uses the same maximum equation for both [cf. Jones 2000, 83–86].

²⁹ F18.36 ~Diels 1882–1895, 292.18. «τρόπους» (‘modes’) is used here for multiple explanations. This term is used by the Sceptic Aenesidemus (first century BC) to describe causal explanations. See the second of his arguments against ‘dogmatic causal explanation’ [Sextus Empiricus, *Pyr. hyp.* 1.181], namely, that such explanations should not be offered ‘according to a single mode’ («καθ’ ἓνα μόνον τρόπον») when ‘explanation in multiple modes’ («πολυτρόπως αἰτιολογήσαι») is possible. Exactly the same consequence is being targeted in the present argument.

F18.39 ~Diels 1882–1895, 292.20 πραγματεία: the term does not mean ‘theory’ [Heath 1913, 276], or ‘study’ [Kidd 1988–1999, 2.133; 3.80] but either an actual treatise or the kind of systematic exercise that would be embodied in one: cf., e.g., Alexander’s usage [Bruns 1887, 30.24].

³⁰ Kidd 1988–1999, F18.32–39.

F18.37–38 ~Diels 1882–1895, 292.19–20 τῇ κατὰ τὸν ἐνδεχόμενον τρόπον αἰτιολογία.

This question about why the planets appear to move as they do was important in the first century BC, a time when the effort to develop or adapt different hypotheses in order to account for planetary stations and retrogradations began in earnest. Geminus, for instance, prefers an eccentric hypothesis for the Sun [*Intro. ast.* 1.31–41] and a hypothesis for the Moon that is based on a Babylonian zigzag scheme,³¹ while Vitruvius [*De arch.* 9.1.5–14] adopts an epicyclic model for the inner planets and an eccentric model (supplemented with a causal component involving the power of the Sun) for the outer planets.³² But, as Robert Todd and I have argued elsewhere,³³ this question is not posed to astronomers: it is asked, instead, of the reader who is plainly one of ‘us’ and so, presumably, a Stoic philosopher with a keen interest in physical theory, assuming that these lines ultimately come either from Posidonius or from Geminus in his summary and exposition of what Posidonius wrote.³⁴ In short, the question is asked of someone who is aware of various ways in which astronomers account for the planetary motions, and its aim is to make him determine for himself why the planets move as they are observed to.³⁵

That this question is addressed to philosophers or physical theorists is not surprising, given, as we have noted, that the astronomers’ assertion that the various hypotheses in use save the phenomena of planetary motion entails

³¹ See Bowen and Goldstein 1996.

³² See Bowen 2001, 826–829.

³³ See Bowen and Todd 2004, 193–199.

³⁴ It is important to remember that such Stoics would belong to the later, Posidonian branch of Stoicism, a branch which is evident in Cleomedes’ *Caelestia*. Not all Stoics were sympathetic to this kind of inquiry: see Strabo, *Geog.* 2.3.8. (On Strabo’s Stoicism, see Mueller 2004b, 75.) Seneca [*Ep.* 88.21–28] ignores it in making the same general point about the relation between physical theory and astronomy, and indicates why in 88.29–46. On Geminus’ philosophical concerns, see Bowen 2012e.

³⁵ See Mueller 2004b, 69–70. Evans and Berggren [2006, 254] misrepresent Kidd 1989–1999, F18.31–35 ~Diels 1882, 292.14–18. Further, their supplement in ‘[The astronomer would answer] that if we assume that their circles are eccentric ...’ is a gross intrusion that goes back at least to Paul Tannery [Heiberg and Zeuthen 1929, 256] and was rejected by Germaine Aujac [1975, 112]. At the same time, it makes the implausibility of their view that the ‘we’ are astronomers obvious. (For his part, Tannery obscures the problematic ‘we’ by writing ‘L’astronome dira qu’en supposant leurs cercles excentriques ...’) For, if the subject is «ὁ ἀστρολόγος», would one not expect ‘he’ instead of ‘we’? And why would the author reported by Simplicius confuse his readers by abandoning his account of ὁ ἀστρολόγος and introducing the plural «οἱ ἀστρολόγοι», and then having these astronomers speak in the first person rather than in the third? It is perhaps not coincidental that Evans and Berggren [2006, 53–58] conflate Posidonius and Geminus, and treat the latter solely or primarily as an astronomer. The case of Cleomedes, however, is ample proof of the untenability of this assumption.

divergent claims about the underlying *realia*. But what exactly is the problem for physical theorists with listing all the possible modes of explanation, that is, with listing every non-causal account of the phenomena covered by each applicable hypothesis?

Recall that a hypothesis can save phenomena *only* if it is the case or true. But knowing that a hypothesis (which concerns some extrinsic feature of an object) is indeed the case requires knowing the underlying *realia*; and this in turn presupposes having a proper causal account of the phenomena. In Aristotelian terms, the problem here is that one usually cannot know *that* a particular hypothesis is true without knowing *why* it is true [cf. 44n25]. Thus, any physical theorist lacking a proper causal account of why the planets move as they do will be much embarrassed when confronted by the various hypotheses put forth by astronomers, since he will not be able to determine which, if any, is in accord with reality. Consequently, when this theorist is asked to account for such phenomena, he will do no better than list all the astronomical hypotheses (and their modes) available to him on the ground that, so far as he knows, each is true or saves the phenomena. And, so, to the extent that these hypotheses are divergent, he will endorse contradictions in physical theory—clearly an undesirable outcome.

This first dislocated paragraph thus turns on its head Aenesidemus' criticism of dogmatism (*scil.* Stoicism, for instance) that it sometimes holds to a single account of phenomena when many are possible [cf. Sextus Empiricus, *Pyrr. hyp.* 1.180–182]. For such sceptics, the existence of many accounts undermined the search for a single causal explanation; but for the Stoic, a multiplicity of accounts demanded it.³⁶

Simplicius continues with yet more text that is dislocated. Though his report initially promises a conclusion based on the preceding lines (note

³⁶ See Bowen and Todd 2004, 197. The point of this paragraph in Simplicius' report is not that the astronomer's hypotheses are false, as Mueller [2004b, 70–71] maintains, but that none is known to be true.

Epicurus advances a view that falls between the Stoic and Sceptic positions. For Epicurus, it is possible to get knowledge of matters in the heavens and thus to secure tranquility and happiness. Such knowledge lies primarily in grasping that they are but the outcome of the original inclusion of aggregates of atoms in the birth of our world. It does not come from the study of risings and settings, solstices, eclipses, and so forth, because such study is not predicated on knowledge of what the heavenly bodies are or of what the most important causes are, and because we have different explanations of the same phenomena (since they are at a distance from us). Indeed, so far as such study goes, Epicurus holds that we will preserve our tranquility and happiness if we are aware of the various ways in which celestial phenomena may be explained. Cf. Epicurus, *Ep. ad Herod.* [Diogenes Laertius, *Vitae* 10.77–80] and *Ep. ad Pyth.* [*Vitae* 10.90–98: cf. 10.113–114] using the text of von der Muehl 1922.

«διδό»), rather than following up on the problem posed by diverse hypotheses for given (planetary) phenomena, it now introduces someone who proposes a single hypothesis about an unspecified motion of the Earth and a stationary Sun.

This is why a certain Heraclides of Pontus³⁷ even came forward to say that [on the hypothesis that] the Earth somehow³⁸ actually moves, and the Sun somehow remains stationary, the apparent unsmoothness [in motion] of the Sun can be saved.³⁹ [F18.40]

³⁷ F18.39 ~Diels 1882–1895, 292.21 τις (a certain): on such usage with a proper name in a derogatory sense, see Liddell, Scott, and Jones 1968, τις II.6 which cites Sophocles, *Philoctetes* 442.

³⁸ 18.40 ~Diels 1882–1895, 292.21: the Aldine text of Simplicius supplied «ἐλεγεν» after «Ποντικός», which would require punctuation that would yield the meaning ‘someone coming along, says (φησίν) Heraclides of Pontus, said that ...’. This would, as some have wished, disassociate Heraclides from the hypothesis reported here. But «ἐλεγεν» was probably originally a gloss on «φησίν» by someone who was pedantically uneasy at having a ὅτι-clause depend on «φησίν» (though this was less of a solecism in later Greek); and it was then later inserted into a text into which it could by sheer accident serve in a syntactically acceptable way. Also, in the older literature it was thought that «παρελθών» indicated a character entering the scene in one of Heraclides’ dialogues. On these and other such exegetical issues and their sponsors, see Heath 1913, 277–282.

κινουμένης πως τῆς γῆς: the genitive absolute describing the Earth and the Sun is obviously the protasis of a conditional sentence; and in the present context that protasis is a hypothesis, as defined just above.

πως (somehow): this adverb is surely indefinite and should not be taken in the sense of ‘in a certain way’ (as by Eastwood [1992, 238] and Evans and Berggren [2006, 254]), so as to suggest an implicit theory with some specificity. What is striking about this indefinite adverb is that, as far as the Earth is concerned, the doxographical report in Diels 1879, 378.3–19, seemingly followed by Ptolemy [Heiberg 1898–1903, 1.24.8–10], describes the Earth’s rotation on its axis from west to east. Perhaps Posidonius/Geminus were aware of this and so the expression ‘somehow’ is a gesture of dismissive indefiniteness rather than a sign of ignorance.

³⁹ Kidd 1988–1999, F18.39–42 ~Diels 1882–1895, 292.20–23.

The problem raised here is why the Sun’s apparent motion is singled out, whereas other reports of Heraclides’ view concern mainly the Earth’s diurnal rotation, which bears on the apparent motion of the fixed stars. But might Posidonius/Geminus have had access to a source not reflected in the doxography [see Diels 1879, 373.3–18] that actually attributed to Heraclides an argument specifically focusing on the Sun, and thus requiring a form of locomotion for the Earth that was incompatible with the theory of its rotation in a single place reported elsewhere? Or, given the derogatory manner in which Posidonius/Geminus refers to Heraclides [see previous note] and the vague way in which the relative states of the Earth and the Sun are characterized, could Posidonius/Geminus just be plucking the Sun out from the list of planets in the previous paragraph and attributing this example without much concern for theoretical precision to Heraclides himself? It is impossible to say with certainty, but the compositional structure (the close similarity between the clauses ‘their apparent unsmoothness (ἀνωμαλία) [in motion]’ in line 35 [292.16–17] and ‘the apparent unsmoothness [in motion] of the Sun can be saved’ in lines 41–42 [292.22–23]) inclines to the second alternative.

This remark about Heraclides is challenging to interpret precisely because its place in the context of what has come before is obscure. But since it does not really bear on the question at hand, it need not detain us now.⁴⁰

Simplicius' report finally draws to a close with a general claim effectively characterizing astronomy first as it is currently practiced and then as it should be practiced.

[F18.45] For, in general, it is not for astronomers to know what is by nature at rest and what sort of things are moved. Instead, by introducing hypotheses of some things being stationary, others in motion, they investigate from which hypotheses the phenomena in the heavens will follow.⁴¹ But astronomers should take as first principles⁴² from physical theorists that the motions of the heavenly bodies are simple, smooth and orderly, and through these [principles] they will demonstrate that the choral dance of all [those bodies] is circular, with some revolving in parallel circles, others in oblique circles.⁴³

[F18.50] That, then, is how Geminus (or rather Posidonius [cited] in Geminus) transmits the distinction between physical theory⁴⁴ and astronomy, and he takes his starting points from Aristotle.

[Kidd 1988–1999, F18.42–52 ~Diels 1882–1895, 292.23–31]

SIMPLICIUS AND THE PATH NOT TAKEN

Simplicius' lengthy quotation of Posidonius/Geminus comes without demurral and, in fact, it amplifies what he writes in commenting on the *De caelo* without introducing any inconsistency. So, as we now see even more

Still, there is Eastwood's well-reasoned proposal [1992, 237–238] that the 'unsmooth motion' of the Sun here is the motion represented by one of the three Eudoxan spheres, and that this transference of a solar motion to the Earth is unsystematically related to the Heraclidean transference of the diurnal motion usually assigned to the fixed stars to the Earth. All one can say is that Simplicius' report is in a sufficiently polemical form as to weaken such speculation at the very least.

Tannery [1899, 307–308] followed by Heath [1913, 282] deleted Heraclides' name from this passage in order to remove what they saw as an inconsistency between this report and other reports of Heraclides' views on the Earth's rotation, with Heath [1913, 282] identifying the «τις» of this passage with Aristarchus, as subsequently have Aujac [1975, 162n7] and Evans and Berggren [2006, 254n18 with 274nc]. But Heraclides' name is in all the manuscripts and treating it as an interpolation on such doctrinal grounds may miss the point.

⁴⁰ For discussion of these lines about Heraclides and other passages relevant to them, see Todd and Bowen 2009.

⁴¹ Cf. *De caelo* 289b1–4 with Simplicius comment [444.18–445.7].

⁴² F18.46 ~Diels 1882–1895, 292.26 ἀρχαί: note that these starting points are now first principles, not hypotheses.

⁴³ Cf. 488.10–14 [p. 135].

⁴⁴ F18.51 ~Diels 1882–1895, 292.30 τῆς τε φυσιολογίας.

fully, for Simplicius, astronomical hypotheses are geometric assumptions about the planetary motions that serve to account for planetary positions. These hypotheses take for granted incidental, quantitative features of these motions. Moreover, though the hypotheses and the accounts derived from them are offered with the presumption that these features are rooted in the *realia*, they come with no demonstrable connection to these *realia*. Consequently, their proliferation is an acute embarrassment: in the absence of a proper physical theory of how the planets really move and why, not only it is impossible to adjudicate the astronomers' competing presumptions that their hypotheses and accounts are true, the only way to 'explain' the phenomena would be to list all their accounts and, thereby, to embrace the contradictions entailed for physical theory.

The solution, for Simplicius, is to abandon the misguided search for hypotheses to save the phenomena—a search that began because people had trouble grasping the idea that the observed planetary motions were not the ones actually made [488.14–18]. In its stead, he imagines a physical theory that provides the astronomers with starting points that are unhypothetical, that is, with assertions rooted by causal demonstration in the nature of the celestial *realia* themselves.

Yet, Simplicius does not provide this theory. As in his commentary on the *De caelo*, so his comment on *Phys.* 193b22–35 clarifies the problem; yet he goes no farther but closes the current *lemma* by raising a lexical matter [Diels 1882–1895, 292.32–293.15] and then, in the next *lemma*, moves on to how the mathematical scientist determines his subject matter. Granted, this may be excusable in his commentary on the *Physica*. After all, the question of truth and astronomical hypothesis is but incidental to the discussion of the distinction(s) made in *Phys.* 2.2. Moreover, though the commentary on the *Physica* was written after that on the *De caelo*, it is apparently to be read *before* the latter [see p. 5]. But this only makes more acute the question, 'Why in his *In de caelo* does Simplicius omit presenting the physical theory which Aristotle promised and which would obviate any recourse to hypotheses?'

The Need for Observation

There are several considerations at work in Simplicius' preference for post-Aristotelian planetary hypotheses and his silence in the face of his contention that no such hypotheses are demonstrably the case. The first is that the relevant phenomena are underdetermined.

One of the key steps in chapters 2.10–12 of the *De caelo* is taken when Aristotle predicates his study of planetary motion on what astronomers say

[cf. 291a29–32]. The fundamental point is that physical theory must not only draw on empirical or observational data, it must also be in accord with them [cf. 291b17–23, 292a3–9]. Such data are sometimes sufficient for a particular inquiry about the heavens that is taken up by the physical theorist [cf. 291a32]. For many such inquiries, however, the data are too sparse, primarily because the celestial objects in question are so remote [cf. 291b24–28, 292a14–18]. Yet, as 2.12 makes clear, even then, though the empirical information is insufficient, it may nevertheless be possible for the physical theorist to give *reasonable* answers to certain questions by making up for this deficiency with philosophical or dialectical considerations [see 97n5]. Thus, in 2.12, the problem of proportionality in the planetary motions is addressed by supposing that the planets are living, rational creatures [292a18–22].

In the case of the competing planetary hypotheses, there is, for Simplicius, sufficient empirical data to rule out the Eudoxan homocentric hypothesis and its embellishments by Aristotle and Callippus. For, according to Simplicius, there is its failure to account for a key observational datum, namely, the putative variation in the size/brightness of certain planetary bodies during their sidereal periods. As for the eccentric and epicyclic planetary hypotheses such as one finds in Ptolemy's works, Simplicius neither mentions any competitors to them nor any phenomenon or phenomena which would rule them out. But such a 'nihil obstat' hardly settles the matter.

The Empirical Limitations of Astronomy

Simplicius can, of course, provide a philosophical consideration—the thesis that the circular motion of aether or celestial matter need not be about the center of the cosmos—which permits adopting eccentric and epicyclic hypotheses. But this particular thesis threatens to undo the chief argument of *De caelo* 1–2 which insists that all the circular motions in and of the heavens be about a specific center, the Earth, because it is the very nature of the celestial matter to move in this way. But even then, all one has are hypotheses which can do no more than claim to be the case.

In truth, however, for Simplicius, the phenomena are not only underdetermined, there is a systematic difficulty in how they are determined in the first place. As he indicates, the problem concerns the empirical data that astronomers report and it removes them even farther from making a positive contribution to physical theory:

One might reasonably wonder why we see the stars themselves with our [organs] of sight but do not hear their sound with our ears. In fact, one should

say⁴⁵ that we do not even see the stars themselves, not their sizes, their shapes or their surpassing beauty, not even at least the motion on account of which there is [this] sound. Instead, we see of them a kind of brightness, as it were, that is in fact of the same sort as the light of the Sun around the Earth: the Sun itself is not seen. It should perhaps not be a source of wonder that the sense of sight is deemed worthy of the radiance and brightness of the heavenly [bodies] because it is less material and more for activity than for being affected and because it exceeds the other [senses] by far; and that the other senses are not adapted to these. [469.21–30]

Simplicius' point is not that our observations of celestial bodies are somehow false but that they are largely matters of inference. That is, as he would have it, while we can see that the accidents and properties of some terrestrial object do indeed belong to that object, this is not possible in the case of celestial objects (except perhaps in the case of the Moon, which Simplicius does not consider). To the contrary, our observations of Saturn, say, entail, for Simplicius, the inference that a given blob of light seen in the night sky at one place is the same blob seen many days later at a different place; and they rest, moreover, on the sometimes plausible but always unverifiable inference that this blob of light which we see belongs to one and the same body.

This is a rather negative assessment of our awareness of the heavenly bodies, especially when coupled with the claim that we do not actually see their motion. The inference to be made is that Simplicius regards all planetary hypotheses in astronomy either as demonstrably false or as provisional. Here, 'provisional' plainly does not entail any expectation that they will in fact be proven true, though, to be sure, that possibility is not excluded in principle; rather, given that astronomy is incapable of proving its hypotheses to be the case, it means that such hypotheses have yet to be falsified and are the best available until the true, unhypothetical account is established in the light of physical theory.

But if this scepticism is in part what underwrites Simplicius' silence and his apparent tolerance for eccentric and epicyclic hypotheses, then, we can get to a final consideration by asking why he undertakes a commentary on the *De caelo* in the first place. More precisely, the question becomes, 'What is there in the rationale for writing a commentary on the *De caelo*

⁴⁵ 469.23 καὶ ῥητέον: several Greek manuscripts add «ἴσως» ('perhaps'), followed by Mueller [Mueller 2005, 126 and n538]. Heiberg's text is, however, supported by Moerbeke's 'Et dicendum quod neque' ... [1563, 165.col. A].

that excuses Simplicius from providing the sort of physical theory which Aristotle apparently fails to provide and still makes writing the commentary a sensible thing to do?

A Question of Priority

To understand Simplicius' undertaking a commentary on the *De caelo* given these circumstances, we must first recall that this scholarly exercise constitutes the practice of philosophy for Simplicius, and that the aim of the practice was assimilation to God [483.19]. As he writes in commenting on *Phys.* 1.9,

since one should call the first separated form divine, good, and an object of desire (that is, the [form] which he calls Intellect and the First Cause), in reality, all things constituted according to nature desire this in that, by the very nature of the divine (that is, by the very being of their cause), they are so constructed that each thing, in accordance with the power which it has, desires assimilation to it. Assimilation is for them their proper perfection; and perfection for composites is rest in respect of form; and for matter, participation in the form to which it is inclined (that is, to which it is adapted).

[Diels 1882–1895, 250.13–17]

This divinity, to whom one prays,⁴⁶ is that from whom the cosmos proceeds and gets its eternal being in an atemporal act of creation.⁴⁷ This Creator God or Craftsman,⁴⁸ as he is also known following Plato,⁴⁹ bears in himself the Ideas which are the paradigms of all that we behold in the sensible world.⁵⁰ For Simplicius, the relation of likeness to paradigm, that is, the relation of the sensible world of becoming to the purely intelligible world of paradigms, a relation otherwise characterized as participation (μέθεξις), entails that the sensible world is inferior or at a lower degree of reality:

As was stated earlier, however, Plato showed in another way that what comes to be comes from some substrate. For, inasmuch as what comes to be is a likeness of being and every likeness assimilates itself to its paradigm, what assimilates itself assimilates itself to [the paradigm] by participation in a process of becoming similar [that arises] from the paradigm. But what participates is one thing and what is participated [in], another; and participation is [the

⁴⁶ 731.25–29.

⁴⁷ 107.12–13, 137.17–28, 138.15–22. See also Diels 1882–1895, 622.26–28, 1141.16–19 and 22–30, 1142.21–25, 1143.26–29, 1145.7–1147.9, 1158.4–5.

⁴⁸ 154.12–16, 360.20–29, 372.15, 489.16–17, 491.6.

⁴⁹ See 304.1, 311.32. See also Diels 1882–1895, 1337.20–33.

⁵⁰ See 87.1–8. See also Hadot 1996, 38.368–390.

process] by which a likeness assimilates itself. Therefore, this thing that participates is that in which and from which the likeness comes to be—the very thing which what comes to be is. (Plato, at any rate, says in the *Timaeus*,

At present, then, three kinds [of thing] should be kept in mind—what comes to be, that in which it comes to be, and that from which what comes to be becomes assimilated.)

And since what I said earlier is true, this is the turning aside from being, that is, the going beyond and descent into non-being,⁵¹ by taking which participation in being takes place as it can and makes a likeness of what really is in the place of what really is not, the very thing which it would have if it descended into what is not completely without producing [a likeness of] what really is.⁵²

Given that the cosmos is a hypostasis of the Craftsman God and the outcome of procession (otherwise characterized as participation in the Ideas within him), the cosmos is an inferior and dependent being, a likeness of a superior reality [138.15–22]. There is, it would seem, a further refinement: the immediate hypostasis of the Craftsman is the celestial sphere or sphere of the fixed stars, whereas the planetary spheres are hypostases of the celestial sphere.⁵³

⁵¹ Diels 1882–1895, 255.13–14 ἡ ἀπὸ τοῦ ὄντος ἐκτροπή καὶ παράλλαξις καὶ εἰς τὸ μὴ ὄν ὑποφορά.

⁵² Diels 1882–1895, 255.3–16.

As Simplicius makes clear in commenting on Epictetus' *Enchiridion*, a text to be studied before the commentaries on Aristotle's works, these paradigms in the Creator God are not ultimate:

On account of this, opposites cannot in fact be first principles, I mean, because their common genus must exist before they do; and, further, because the one must also exist before the many since each one of the many must exist by sharing in the first One or there must actually be nothing. Furthermore, if before every characteristic there must exist a primal unit from which the characteristic divided among the many exists—for all beautiful things proceed from the divine and primary Beauty and every truth from the first, divine Truth—the many first principles must also reach back to a single first principle, not to one that is some particular first principle (just as each of the others), but to a first principle which rises above and transcends all other first principles, and which takes to itself all [first principles] and in the same way as nature offers from itself to all its primary quality along with the diminishment of character befitting each. So, then, saying that the *first* principles are two [in number] or, in short, more than one is absurd. [Hadot 1996, 35.16–30]

See Baltzly 2009, for argument that, for Proclus, truth is a property not just of the representations of things (thoughts, statements) but also of the things themselves, an argument which suggests that degrees of reality may also be degrees of truth.

⁵³ 487.20–488.2. See also Comment 10.12, pp. 210–211.

From this much we may draw a two-fold conclusion. First, to understand the planetary motions one must ultimately understand the paradigms in the Craftsman. Thus, while it would seem that for Simplicius the sparseness of observational data and its compromised nature are reasons to question the value of developing a physical theory that accounts for them directly as one would for terrestrial objects, he is committed to the view that the understanding desired actually comes with the philosophical discipline that effects assimilation to the Craftsman God, the Creator of the heavens. Such assimilation will, to be sure, bring a different kind of understanding than that of the typical astronomer, to say nothing of the physical theorist who is obliged to rely on astronomy. Nevertheless, for Simplicius at least, it is an understanding that is vastly preferable. Indeed, it is also necessary: for, without such understanding, it will be impossible to discern those starting points which the astronomer must have (and wants) if his theorizing is to be unhypothetical and true. So, in sum, the answer to the question left hanging at the end of *In de caelo* 2.12 really just is to continue with Aristotle's chapters.

Accordingly, Aristotle's *De caelo* remains a necessary step in the long progression constituting this philosophical discipline since it acquaints the reader with the simple bodies that make up the cosmos, starting with that eternal and unchanging simple body which constitutes the heavens and on which the interactions of the other four simple bodies depend [4.25–5.34]. As for the motions of the first simple body or aether, one may infer that any concern about Aristotle's planetary hypotheses is actually minor. It is far better to follow the lead of *De caelo* 1–2 and to concentrate primarily on the nature of aether and its 'paradigmatic' occurrence in the celestial sphere.

As for Simplicius' own commentary on this treatise, its rationale is obvious. This commentary stands as a necessary bulwark and defense against the blasphemous attack mounted by John Philoponus on the conviction that the cosmos created in an act before time by God is both eternal and ungenerated⁵⁴ since this impious attack threatens the very discipline that can demonstrate its emptiness and so turn it aside.

⁵⁴ See pp. 10–15.

CONCLUSION

The conflict between Simplicius and Philoponus exposes, on Simplicius' side at least, a critical tension between Simplicius' desire for salvation in or from a world that afflicts him and the very human desire born of both fear and wonder to understand that world. Granted, this tension is, for Simplicius, to be resolved by further reading, reading which presupposes and confirms that there are degrees of reality and, hence, of truth. And so, Simplicius' response to a scientific problem, the plethora of conflicting astronomical hypotheses each held to represent the *realia*, is not to enjoin more astronomy or even the development of a new physical theory that draws on astronomy, but to continue that process of philosophical education by which men assimilate themselves to the Craftsman God, that God whose thoughts are paradigms and causes of the cosmos and all that is in it. For it is then, when they are assimilated, that men will truly understand how and why the heavens move as they do.

Chapter 1 set out the challenge facing Simplicius in abandoning homocentric planetary hypotheses in favor of the eccentric and epicyclic hypotheses developed after Aristotle. In this chapter, we have focused on his contention that no astronomical hypothesis is demonstrably true, though each is offered in the presumption that it is the case in so far as it saves or accounts for the phenomena. But we have still not exposed the full nature of Simplicius' *apologia* in the face of Philoponus' criticism. So far, I have suggested how the contention about astronomical hypothesis in general need not impugn Aristotle or the inclusion of the *De caelo* in the late Platonic program of philosophical education. Still, one may well wonder about the point of declaring a preference for post-Aristotelian hypotheses. To clarify this and to understand more fully the nature of Simplicius' apparent agreement with Philoponus in the matter of celestial motion, we should next inquire whether Simplicius thinks that by following such astronomers as Ptolemy he is redressing mistakes made by Aristotle. But this is in turn a question about how Simplicius understands Aristotle's commitment to homocentric theory. In other words, it is question of how Simplicius maintains Aristotle's authority and standing as the acolyte of Plato. And so we come to the subject of the next chapter, Simplicius, the apologist.

CHAPTER THREE

SIMPLICIUS, THE APOLOGIST

Let us recapitulate. When Philoponus attacked Aristotle for holding that circular motion is by definition motion about the center of the Earth [32.1–11], his aim was to overthrow Aristotle's argument that there was a fifth simple body that moved by nature in a circle and, with it, the argument that since this simple body does not suffer any form of change other than a change in position that has no opposite, the heavens and, ultimately, the universe are capable of neither generation nor corruption but must be eternal. To Simplicius, then, this attack was especially serious. For present purposes, it is important to note that in rejecting the notion that circular motion is by definition about the center of a geocentric universe, Philoponus also rejected any homocentric theory of planetary motion such as one finds in *Meta.* Λ.8. But here, and most surely to Simplicius' great dismay, was a point on which he actually agreed with Philoponus. And so Simplicius was forced to mount a complex defense that aimed to save Aristotle as an authority, the *De caelo* as a valuable text in the late Platonic program of education, and the late Platonists themselves. This complex response or *apologia* comes as the great digression [492.28–510.35] in the commentary on 2.12, though elements of it do appear earlier at strategic points.

Philoponus' polemic certainly puts Aristotle, the *De caelo*, and the late Platonists in an awkward position. But Simplicius yields nothing. His defense of Aristotle against Philoponus admits the basic facts but then reinterprets them completely. Indeed, in dealing with the question about the heavenly motions, Simplicius makes explicit that the homocentric hypotheses described in *Meta.* Λ.8 are flawed [504.16–505.19], and that along with his fellow Platonists he prefers the hypotheses developed after Aristotle [506.9–16] and perfected in the treatises by Claudius Ptolemy.¹ Yet, so far as Philoponus is concerned, this defense is oblique and curiously muted: by the time one gets to the digression/*apologia*, not only is Philoponus pushed into oblivion, the *apologia* itself would seem to stand on its own as a simple lesson to bring the faithful up to date in matters of technical astronomy,

¹ On Ptolemy as an authority, see pp. 84–86.

were it not for a few veiled remarks indicating what has actually provoked it. This is understandable. There would, after all, be little gained by giving any credibility to the idea that Philoponus had found a good reason to reject Aristotle or by drawing attention to a point in which Philoponus and the late Platonists coincided.² In any case, in opposing the heretic Philoponus on an inescapable point about which they agree, Simplicius instead speaks directly and only to the faithful by veiling the fact that what he has to say is an *apologia*, thereby concentrating quite sensibly on the proper interpretation of this point and not on its *mis*interpretation.

SAVING ARISTOTLE

First in order of duty is that we should be clear about the Aristotle who is to be saved.

The Harmonized Aristotle

For Simplicius, Aristotle is an acolyte: his works are propaedeutic to the reading of Plato. How exactly this works Simplicius makes clear when he writes in the course of delimiting the authority to be granted to an earlier commentator on Aristotle:

Alexander of Aphrodisias in other instances appears to follow Aristotle's arguments well, I think, and even better than the other Peripatetics; but in what is argued by Aristotle against Plato, he no longer seems to me to observe the focus of Aristotle's opposing argument, [a focus] aimed at the *apparent* [meaning] of Plato's arguments. Rather, [Alexander] objects to [Plato] in a somewhat mischievous manner and, in consideration of simple-minded folk, tries to refute not only his apparent meaning (just as Aristotle did in fact)³ but also attacks the concepts of the divine Plato and undertakes to draw conclusions from the arguments which often do not follow the apparent meaning. Well, inasmuch as this is the case, here too, in putting forth Alexander's [views of] what Plato thought about the motion of the soul and setting them against the truth that is dear to God and to Aristotle, I will try to examine them closely on account of those who read⁴ [Alexander's] arguments rather superficially and who risk being filled with misgivings about Plato's doctrines and saying the same thing [as Alexander] both about Aristotle's [views] and about the divine truth. [377.20–34]

² See Comment 12.27, pp. 284–288.

³ See, e.g., Diels 1882–1895, 295.12–18.

⁴ 377.32 ἐντυγχάνοντα; see Todd 2008, 219.

This assessment of Alexander and the assertion of the essential unanimity of Plato and Aristotle are found elsewhere and often in the *In de caelo*.⁵ Such differences or disagreements as there may appear between Plato and Aristotle are, for Simplicius, purely lexical and derive in large part from Plato's preference for elevated language and Aristotle's for common speech.⁶ Thus, as Simplicius states in his commentary on Aristotle's *Categoriae*,

[a good interpreter] should, I think, even when [Aristotle] speaks against Plato, not look to the [written] text alone and condemn the discord of the philosophers but look to the sense and track down their concord in the greatest matters. [Kalbfleisch 1907, 7.29–32]

This idea that Plato and Aristotle are in essential agreement is a fundamental principle that governs or structures the reading and interpretation of Aristotle.

In sum, the Aristotle to be saved is not the one known to scholarship today nor to Philoponus and later Christian writers. Such Christian writers, gifted with the promise of salvation made in texts concerning the life of Jesus, were freed of the late Platonic need to read Aristotle as an acolyte of the divine Plato, prophet of the Craftsman God.⁷ Still, it remains true that they, like the late Platonists, refracted Aristotle through a program of reading which both expresses and constitutes a religious life. But, be that as it may, the Aristotle that Simplicius sets out to save is in large measure the creature of a program of reading now defunct. It would be obtuse to judge his success in the light of present-day expectations.

Aristotle, the Physical Theorist

One key step in Simplicius' *apologia* is the distinction drawn in the first century BC and well entrenched in the commentary tradition between the physical theorist and the astronomer.⁸ This distinction serves him in numerous

⁵ See, e.g., 143.9–22, 287.2–12, 297.1–298.26, 353.3–10, 360.20–29, 587.26–588.3. For a list of occurrences of «συμφωνία» as this term bears on agreement among philosophers in Simplicius' commentaries, see Baltussen 2008, 218–220. On the broader question of harmonization as a tenet of late Platonist reading, there is a sizable literature: see, e.g., Gerson 2005, Karamanolis 2006.

⁶ See 69.11–15, 647.27–28, 679.27–31. On how Simplicius grounds this putative preference in a difference in the evidence that Aristotle and Plato consider and in how each supposedly accesses this evidence, see Hoffmann 1987, 78–79. For Simplicius, Plato argues from νοῦς and νοητά and Aristotle, from αἰσθησις and αἰσθητά—a claim presumably made with the Divided Line of *Resp.* 6 in mind.

⁷ See Wildberg 1999, 118–120.

⁸ See Chapter 2, pp. 37–57.

ways. But, in defending Aristotle for his propounding a failed astronomical theory, it mitigates Philoponus' criticism in two respects. First, it incidentally lessens the significance of Aristotle's error by pointing out that *all* such hypotheses, not just the ones that Aristotle discusses, lack necessity and that none is known to be true. Second, and more important, it allows Simplicius to segregate Aristotle, the physical theorist, from all astronomers, that is, from all who devise hypotheses and confound the fact that they save the phenomena with the claim that they are indeed the case. But, if Aristotle is not an astronomer, is he nevertheless a philosopher *qua* physical theorist committed on *other* grounds to the view that the homocentric hypotheses are true?

The defense of Aristotle is declared without elaboration early in the commentary, when Simplicius first introduces Philoponus and his criticism of Aristotle's thesis that circular motion is by definition motion about the center of the cosmos.⁹ There, Simplicius asserts, Aristotle actually held that circular motion was motion about *a* center; moreover, his arguing on the assumption that this center has to be the center of the Earth is a consequence of his using the astronomical hypotheses then available to him, hypotheses put forth by the Eudoxans/Callippans. The fact that there is now disagreement about the hypotheses is hardly surprising and not a reproach, Simplicius adds, since all the hypotheses in play have been devised in response to the question, 'By hypothesizing what can the phenomena be saved?', a question that Simplicius regards as resting on a fundamental misconception [cf. 488.14–18]. But, since Simplicius and Philoponus agree in rejecting Aristotle's homocentric hypotheses of planetary motion, Simplicius declines to develop his defense at this delicate moment in his commentary and deflects Philoponus with a contemptuous polemic in which he speculates about how Philoponus might ever have come to think that the heavenly bodies rotate about their own axes [32.34–33.16]. Underlying this, I suspect, is the realization that he can use the very structure of the *De caelo*—Aristotle takes up the question of planetary motion much later, in 2.10–12¹⁰—to distance himself from Philoponus' introduction of 'modern' planetary hypotheses to criticize Aristotle.

So, it is not until commenting on 2.10 that Simplicius begins laying the groundwork for his fuller defense. Thus, *In de caelo* 2.10 draws attention to the fact that in discussing the planetary motions from here on, Aristotle's

⁹ 32.1–33.16. See Comment 12.27, pp. 284–288.

¹⁰ See pp. 8–10.

theorizing will be on the basis of works in astronomy [470.29–471.2]. This remark effectively distinguishes Aristotle's concern with the heavens and that found in the astronomical works themselves. Just what these works might have included Simplicius indicates (on the authority of Eudemus) by mentioning earlier work bearing on the proportionality of the planetary sidereal periods by Anaximander and the Pythagoreans, adding significantly that such work was greatly improved by Ptolemy, who is very plainly cast as an astronomer.¹¹

Here then, in a matter of limited scope—it does not open into the debate about the eternity of the heavens—Aristotle, the philosopher, is shown addressing a question in physical theory on the basis of astronomical learning which was known later to be inferior, if not just wrong. It is apposite that Ptolemy is mentioned last in a list of those who have perfected the astronomical theory of the sizes and distances of the planets.

Next, in commenting on *De caelo* 2.11, Simplicius details how Aristotle's turn to observation and astronomical theory works in support of argument in physical theory. The immediate subject is the conclusion established in chapter 2.8 that the heavenly bodies are spherical. The only hiccup, as it were, is a defense of Aristotle the philosopher *qua* physical theorist from a charge of circular argumentation.¹²

In de caelo 2.12 begins by elaborating the two problems of 2.12 and then teases out from Aristotle's text his solution to the first [480.26–487.20]. At this point [487.20–488.9], without any mention of Philoponus, Simplicius reprises the defense of Aristotle first indicated in his comment on *De caelo* 1.2.¹³ He now draws attention to a key assumption underlying this first problem: that the planets make many motions of different kinds, a claim which *he* takes to mean that, for Aristotle, the planets make direct motions, stations, and retrogradations.¹⁴ After remarking that this assumption is also made by those who posit any one of the astronomical hypotheses currently known, he implies that none of these astronomical theories is demonstrably the true account because none derives from a proper physical theory [488.9–14]. In fact, he says, this failure to develop a physical theory with a proper distinction of the real and the apparent is what underlies the devising of astronomical hypotheses that can at best be consistent with the

¹¹ 471.4–11. See also p. 81.

¹² 477.24–478.14. On Alexander's proposed defense, see p. 77.

¹³ See Comment 12.27, pp. 284–288.

¹⁴ See Comment 12.07, pp. 230–248.

phenomena by saving them [488.14–18]. In support, Simplicius cites Eudemus and Sosigenes to say that this ‘second-best’ project originated with Plato and was first advanced by Eudoxus.¹⁵

Thus far, Simplicius has discredited all astronomical hypotheses in favor of a proper physical account, and he has put Eudoxus with the astronomers in distinction to physical theorists like Aristotle. Next, after some remarks on the first problem itself,¹⁶ Simplicius supports his insistence on the value of a proper physical theory by mentioning Plato’s view that the planets have in reality (or by nature) diverse unsmooth motions that are nevertheless ordered [489.5–11]. The force of this remark, I surmise, is that Plato’s challenge to develop hypotheses to save the phenomena was, in Simplicius’ view, actually meant as an invitation to analyze the ordered unsmoothness of the planetary motions and to gain an understanding thereby of their nature. Thus, Simplicius’ remark about Plato at this juncture suggests that, in his view, Eudoxus and the others misconstrued Plato by taking him to enjoin the development of mathematized astronomical theories that did not address any questions of nature.

After dispatching Alexander’s criticism of the thesis that the planets are ensouled and act,¹⁷ Simplicius turns to the second problem and its solution [489.33–492.24]. Once more he notes that this problem assumes a homocentric theory of planetary motion which, like any rival astronomical theory, lacks necessity, as he has stated earlier [492.24–28]; and with that he begins the great digression [492.28–510.35].

The digression is the *apologia* in full. It begins by restating for a third time the story of the great challenge in planetary theory, but on this occasion with even more ‘historical’ detail and no attribution [492.31–493.11]. Plato is now said to have held unequivocally that the heavenly motions were smooth, circular, and ordered. (There is no mention of his idea that they might also be diverse and unsmooth by nature.) Moreover, rather than write vaguely of Eudoxans/Callippans [see 32.16], Simplicius once again names Eudoxus [see 488.18–24] as the first Greek to take up Plato’s challenge and then supplies new details about Callippus, Aristotle, and their collaboration.

The crux of Simplicius’ defense of Aristotle thus becomes the nature of this collaboration. Simplicius has already established that Eudoxus’ response to Plato’s challenge was (contrary to its intention?) astronomical in that it involved positing hypotheses purporting to save the phenom-

¹⁵ 488.18–24. See pp. 81–83.

¹⁶ 488.25–489.4. On this passage, see pp. 69–71.

¹⁷ 489.12–30. See p. 78.

ena.¹⁸ Moreover, he has suggested even earlier that the Eudoxans/Callippans (and thus *perhaps* Callippus himself) responded as astronomers too.¹⁹ But, though he has hinted that Aristotle's commitment to the hypotheses was of a different sort, Simplicius now brings front and center the question of how Aristotle, the physical theorist, understood the homocentric hypotheses for planetary motion. In short, the question is, 'What was the nature of Aristotle's interest in this collaboration?'

At this stage, Simplicius allows only that with Callippus Aristotle corrected and supplemented Eudoxus' hypotheses and that, given his conviction that all the heavenly bodies move by nature about the center of the universe, he was pleased with the homocentric hypotheses [493.9–11]. Yet, in connecting Aristotle's delight in homocentric hypotheses and his view that all heavenly bodies move about the center of the universe, Simplicius raises the question of how Aristotle's work with Callippus compares with his consulting the written works of Anaximander and the Pythagoreans on the proportionality of their sidereal periods. In particular, he broaches the questions:

- 'Did Aristotle undertake this collaboration in the same spirit with which he enjoins consulting written works in astronomy?'
- 'Were the hypotheses that Callippus and Aristotle worked on like the substantive claims of Anaximander and the Pythagoreans in being inadequate or wrong and subject to subsequent improvement?'

All one can say at this juncture is that, as Simplicius would have it [32.12–29], the homocentric hypotheses were the only ones on offer in Aristotle's time.

The digression continues by reconstructing the planetary theory of *Meta.* A.8. In 493.11–497.5, Simplicius sets out the Eudoxan theory; and in 497.6–24, the Callippian corrections (which incidentally show Callippus to be theorizing as an astronomer). In 497.24–498.1, Simplicius supplies the rationale for the addition of unwinding spheres, a rationale elaborated on the authority of Sosigenes²⁰ and then followed by a reckoning of the total number of spheres required by this homocentric theory [503.27–504.3] and a concluding lexical note.²¹

¹⁸ See pp. 81–83.

¹⁹ See Comment 12.27, pp. 284–288.

²⁰ 498.1–503.27. See pp. 283–284 (Comment 12.26), 86–87.

²¹ 504.4–15. At this point, it would appear that Simplicius' story of collaboration between Callippus and Aristotle may amount to no more than an inference from *Meta.* A.8 itself.

Next and at some length comes a fundamental criticism of the homocentric hypotheses: they do not allow for the (putatively) observable variation in the size (brightness) of the planets at apogee and perigee.²² This criticism shows that the fourth-century homocentric hypotheses were, like the views cited earlier of Anaximander and the Pythagoreans, inadequate and flawed. Indeed, in these passages, Simplicius bring to light a basic predicament faced whenever a physical theorist consults astronomers and their work: the very best he can do is to adopt hypotheses that have yet to be falsified. Thus, not only does the physical theorist risk taking on hypotheses that are false or inadequate, there may be occasions in which such inferior accounts are the only ones available. Indeed, as Simplicius would have it, the only planetary hypotheses known to Aristotle were unsuccessful attempts to address (one interpretation of) Plato's challenge in that they could save only *some* of the relevant phenomena [504.16–25: cf. 505.17–19].

The question, therefore, is whether Aristotle was aware of this. As Simplicius subsequently makes very clear [505.19–506.8], he was. In truth, it is essential to Simplicius' defense of Aristotle and his authority that Aristotle knew of the variation in planetary size (brightness):²³

And even Aristotle in his *Problemata physica* clearly sets forth further problems for the astronomers' hypotheses based on the fact that the sizes of the planets do not appear to be the same. Thus, he was not completely satisfied with his turning [spheres], even if [the thesis] that they are homocentric with the universe and move about its center won him over. And, further, from what he says in *Metaphysics* Λ, he is evidently not one who thinks that the [features] of the motions of the wandering [stars] have been stated adequately by the astronomers up to and during his time. [505.23–30]

Here 'won him over' (ἐπηγάγετο αὐτόν) does register commitment of some sort. Simplicius has already suggested that Aristotle liked the homocentric hypotheses because he thought that all the heavenly bodies move about the center of the universe [493.9–11]. The implication is that Aristotle's real commitment was to his arguments establishing aether. For Simplicius, so far as the homocentric planetary hypotheses went, Aristotle's was the qualified, tentative commitment of a physical theorist who knows that these hypotheses are inadequate but is obliged nevertheless to adopt them because they are the only ones in hand, and because without them he could not elaborate

²² 504.16–505.19. See Comments 12.28–12.30, 12.32–12.33 on pp. 288–291, 291–293.

²³ See Comment 12.34, pp. 293–294.

his position, that is, an answer to the question of the number of unmoved movers that opens *Meta.* A.8. Such commitment is plainly heuristic and very provisional. It is obviously to be distinguished from the astronomer's blind, unquestioning presumption that these hypotheses simply are the case when they enable explanation of the phenomena. This, then, is the context for interpreting Simplicius' earlier contention to Philoponus that

in these [lines] Aristotle is only saying this much, that motion in a circle is [motion] about *a* center, since this befits *every* circular motion. But if he says elsewhere that bodies moving in a circle move about the center of the universe, one should understand that he is making his case in accordance with the hypotheses of earlier astronomers. [32.12–16]

Simplicius' defense of Aristotle concludes with yet another exculpatory remark, namely, that Aristotle's adoption of homocentric planetary hypotheses came at a time before the influx into Greece of Babylonian observations of yet even more phenomena that astronomers should take into account in devising their hypotheses [506.8–16].

So far as the putative collaboration of Aristotle and Callippus is concerned, the upshot is that, for Simplicius, this was a coincidence of two very different projects and replete with reservations on Aristotle's side. For his part, Callippus, though concerned to represent more phenomena than the ones originally covered by Eudoxus, was nevertheless, it would seem, committed to homocentrism.

Conclusion

To account for Aristotle's talk of homocentric planetary hypotheses, Simplicius draws attention to the fact that Aristotle, very reasonably it must be admitted, turns to astronomers and their writings in order to address questions in physical theory about the planets and their motions. But this is a strategy with risks. As Simplicius points out, the homocentric hypotheses in Aristotle's time stood alone: there were no rivals. Moreover, it was known to Aristotle and to others that these hypotheses were inadequate: they accounted for only some of the relevant phenomena. Indeed, as Simplicius also indicates, there were efforts to improve upon them (Callippus) and even to devise new ones that were more capable (Autolycus) [504.20–25]. The upshot, in Simplicius' view, is that Aristotle, the physical theorist, was fully cognizant of this and that his talk of the homocentric hypotheses did not entail real commitment to them. Rather, it was wittingly provisional in the sense that what he says is constrained by what his predecessors and contemporaries understood about the planetary motions. If one wants the

truth, Simplicius implies, one has to look elsewhere in his writings, bearing in mind, of course, the fundamental harmony of his views and those of the divine Plato.

In this way, Simplicius saves Aristotle. As he sees it, Aristotle retains his standing as an authority in the school of late Platonism and it is Philoponus who has fallen into blasphemy by misinterpreting the fact that Aristotle adopts homocentric planetary hypotheses. But what of the *De caelo* itself? Should one still bother to read it? Plainly, though it helps, saving Aristotle does not by itself secure the place of this text in the late Platonic program of education.

SAVING THE *DE CAELO*

There are several ways in which Simplicius maintains the value of the *De caelo* as a text to be read in the long process of assimilating to the Craftsman God. The first comes in the opening discussion of the *De caelo*'s σκοπός or focus.²⁴ This discussion, though perhaps a commonplace in late Platonic commentary, has an especially salutary purpose in the *In de caelo*. After surveying various earlier accounts of the focus of this treatise, Simplicius concludes:

Thus, I think that in these [books] Aristotle is clearly making his account about the heavens and the four elements below the Moon. But, in order that their focus not be drawn out but shown as looking to one thing, one should say that after the account of the physical principles, that is, whatever principles there are of natural bodies, he speaks of the simple bodies, the ones which are constituted from the natural principles and are parts of the whole.²⁵

This conclusion effectively maintains the value of *De caelo* apart from any concessions that Aristotle might make in it to homocentric planetary theory.

Another line of defense consists in showing that in 2.12, a chapter understood to allow that the planets make stations and retrogradations, the two leading problems may also be addressed if one assumes eccentric or epicyclic hypotheses. So far as the first problem is concerned, Simplicius does not do this explicitly. All he states is the argument that, if the planets are ensouled and active, a premiss essential to the solution of the first problem, it would be better to hold that every body moving in a circle moves about

²⁴ 1.1–6.27. On the translation of this term, see Hankinson 2002, 19 and n2.

²⁵ 4.25–31. This is elaborated in 4.31–5.37.

its own center and not necessarily the center of the Earth. The implication, I take it, is that if one adopts eccentric or epicyclic hypotheses, it is still possible to make sense of the first problem of 2.12 and to give an answer along the lines indicated in the commentary on it.

So far as the second problem goes, however, for Simplicius, its value becomes murky if one adopts non-homocentric planetary hypotheses [509.21–22]. As he explains, from the standpoint of such hypotheses, the talk of equalization at *De caelo* 292b30–293a4 [cf. 490.19–491.11] makes little sense [509.22–26]. Nevertheless, he says, this problem still has *partial* force if one adopts a system of nested spherical shells, as he in fact does.²⁶

In this way, the *De caelo* and especially 2.12, though limited by its reliance on astronomers and their writings, is shown to have value that is independent of any of the particular astronomical hypotheses known to the late Platonists. What is more, as I have suggested, this limitation may be of little real consequence if the *De caelo* is understood as a stage in a course of reading and study which will ultimately bring that unhypothetical understanding of the planets and their motions which is lacking in physical theory of the time. In other words, any concern with such limitations dissipates once *De caelo* is construed as a text necessary to the education of that philosopher who will enunciate the physical theory needed to supply those starting points (ἀρχαί) in terms from which astronomers can derive a proper (unhypothetical) quantitative/predictive account of the heavens and how they move.

SAVING THE LATE PLATONISTS

The bulk of the work in Simplicius' redeeming himself and the late Platonist preference for more recent astronomical hypotheses comes in demonstrating that Aristotle was not really in error in adopting homocentric hypotheses—or, at least, that his error in this was hardly as grievous or even the same as that of the astronomers who actually proposed and maintained them. (One must, surely, distinguish between being forced for the sake of argument to adopt hypotheses suspected to be flawed or false and thinking them to be true because they save the phenomena.) Redemption also comes with making clear that the *De caelo* retains its value as a text in the late Platonist program of education.

²⁶ 510.8–23. On «μήποτε» in 510.19, see 102n32.

But what remains is to show that the late Platonists, in preferring epicyclic and eccentric astronomical hypotheses as expressed authoritatively in Ptolemy's *Hypoth. plan.*, say, are nevertheless not really committed to them. This last exculpation is an obvious consequence of Simplicius' contention that no astronomical hypotheses are demonstrably the case, that the true account of the heavens and their motions proceeds instead by deduction from premisses in physical theory, specifically, from the premiss that the real motions are circular, smooth, and ordered. It is further reinforced by Simplicius' insistence that the epicyclic and eccentric hypotheses, not just the homocentric hypotheses, are flawed [504.16–507.8, 510.24–26].

But why choose among hypotheses if none is demonstrably true and all are inadequate? Surely, it would make more sense to abstain. The answer lies in remembering that, for Simplicius and the late Platonists, speculation in physical theory is a necessary stage in the educational progress from Aristotle to Plato and, ultimately, to assimilation to the Craftsman God, and that such speculation has to be in accord with observation and scientific theory. So, granted that the astronomical hypotheses devised more recently are superior empirically to those available to Aristotle, in choosing the former, Simplicius and the late Platonists prove to be following Aristotle both in his practice and in their sense of his teaching. But Simplicius also wants to convey a further sense in which they are like him: for, as he makes clear, just as Aristotle [505.27–506.8], so he and his school are aware of the inadequacies of the theories that they choose [510.24–31]. The main difference between Aristotle and the late Platonists turns out to be that they are in a better position to see the shortcomings of speculation based on homocentric hypotheses.

Simplicius makes this sufficiently plain in 509.16–26 when he mentions the limitations to answers based on non-homocentric hypotheses to the two central problems of *De caelo* 2.12. As for answers assuming homocentric hypotheses at 488.25–489.4, he shows that these too have their limitations.

He wonders, for instance, about the need for raising the first problem if all hypotheses are not proven true. To be sure, this is a valid question²⁷ but one that is easily answered. After all, as Simplicius himself implies, Aristotle *had* to raise the first problem as he did because he was writing on the basis of contemporary astronomical works with and for people who recognized various planetary motions and were trying to devise homocentric hypotheses

²⁷ 488.25–30. I take this to be a real question arising for Simplicius from his view of all astronomical hypotheses in general: it is certainly formulated in a way that makes sense only with the development of astronomical hypotheses after Aristotle.

to account for them. But, for Simplicius and his colleagues, there is no such need since they are working at a time when better hypotheses are available. Indeed, as Simplicius goes on to say,

But, since we are obliged to hazard making these sorts of comparisons in general,²⁸ perhaps it is not necessary for us to define the merits [of the planets] in regard to the distinction between their places; but [it is necessary for us] to say that each has been posted in the place where it benefits the universe.

[488.29–489.1]

This remark then opens into a teleological account of where the planets are (and, presumably, of how they move) befitting a lesson in the late Platonic school itself.

Thus, since bodies beneath the Moon do not have their own light but are illuminated from without, ‘the two lights of the cosmos’ have rightly, one might say, been stationed proximately above them, perhaps because [these lights] have the simplicity of their motions for what is better than what is composite.

[489.1–4]

It would be wrong, of course, to see this as a repudiation of Aristotle’s first problem or even of the solution given in the *De caelo*: coming when it does, this remark registers instead the fact that the first problem assumes only that the planets make diverse motions and suggests that this diversity can also be explained teleologically without presupposing any specific astronomical hypotheses.

CONCLUSION

With the completion of his *apologia*—his great defense of Aristotle’s authority, the value of the *De caelo*, and the late Platonist preference for non-homocentric planetary hypotheses—the burden of Philoponus’ criticism of Aristotelian aether is lifted and Simplicius moves onwards to a less fraught commentary on the remainder of the *De caelo*. He has shown that such agreement as there is with Philoponus about the inadequacy of the homocentric hypotheses is merely superficial. Where Philoponus takes this inadequacy as evidence of an error that ultimately vitiates Aristotle’s argument for the eternity of the cosmos, Simplicius construes it as but an instance of the inescapable fact that any physical theory of the heavens and their motions must be in accord with observation and the (empirical) science of

²⁸ 488.31: this obligation arises from the central questions raised in *De caelo* 2.10 and 12.

the day, and that this science can at best provide hypotheses that are consistent with all the relevant phenomena known at the time. Moreover, unlike Philoponus, I suspect, Simplicius does not hold that the non-homocentric hypotheses devised after Aristotle are much better: at least, while they may account for more of the putative phenomena, in his view, they still promise only consistency with the *realia*, not truth, and are, accordingly, likewise flawed. For Simplicius, then, the path to salvation through Aristotle to Plato and the Craftsman God remains open and is indeed the only course.

For us, there is still one task left: to review how Simplicius deploys his sources to construct his history of astronomy and the early Peripatos.

CHAPTER FOUR

SIMPLICIUS, THE HISTORIAN

Simplicius' commentary on *De caelo* 2.10–12 plainly has aims alien to Aristotle's text. As we have seen, one of its goals is to expound what Aristotle means in a way that excuses Aristotle for proposing astronomical hypotheses that are inadequate, while at the same time preserving the value of the *De caelo* as a 'sacred' text and exculpating those late Platonists who prefer hypotheses of the sort put forward by Claudius Ptolemy. Such a complex goal, however, demands a careful 'reading' of Aristotle and the history of astronomy in his time and afterwards. In this Chapter then, I will focus on this 'reading', that is, on how Simplicius uses previous literature in constructing his *apologia*.

I will start with Simplicius' citations of earlier writers in order to indicate the variety of ways in which they serve him. But let me be clear. I will not say much about the accuracy or fidelity of these citations. Were I to undertake this, the immediate problem would be that in his commentary on 2.10–12 Simplicius cites texts that are no longer extant: Alexander's commentary on the *De caelo*, Eudemos' *Astronomical History*, and an unnamed work by Sosigenes. Speculation about the accuracy of these citations, given in addition the uncertainty about whether they are quotations, paraphrases, or reports, would, therefore, be tenuous if not simply nugatory. Granted, it is feasible to assess the substance of some of Simplicius' citations of Alexander by considering works by Alexander that have survived. But no such remedy is available for the citations of Eudemos and Sosigenes. Fortunately, such speculation is not directly pertinent to understanding what Simplicius is attempting and why he marshals his sources as he does in explicating *De caelo* 2.10–12. For that, it will suffice to pay close attention to what he actually writes.

SIMPLICIUS AND HIS SOURCES

The question of sources is further complicated by the fact that Simplicius' is the only commentary on Aristotle's *De caelo* that has survived in Greek from Antiquity. There is a paraphrase of the *De caelo* by Themistius that is extant in a Hebrew version which was translated into Latin. The few parallels

between the Latin version of Themistius' text and Simplicius' commentary on 2.10–12 are general and support at most the conclusion that late Platonic reflection on the *De caelo* was to some degree structured by the idea that certain topics had to be addressed in considering given passages, an idea that may ultimately point to the centrality of Alexander's lost commentary.¹ In any case, though he does refer to him several times earlier, Simplicius does not mention Themistius when he comes to comment on 2.10–12.

In the main, however, we are at a loss for means of determining whether Simplicius uses sources tacitly either within or without the commentary tradition in his *In de caelo* 2.10–12. Accordingly, then, this is yet another line of inquiry that I will not pursue. My focus instead will be limited to discovering what we may learn from his explicit citations of other writers. This has admittedly the consequence that the analysis given in this Chapter will be liable to correction in the light of future discoveries and research. But, as the reader may well expect by now, it is, in my view, far better to be demonstrably wrong in this way than to hold forth in the interminable limbo of the possibly right.

Alexander of Aphrodisias

Alexander² is an important source in Simplicius' commentary on the *De caelo* and Simplicius' citations of him serve purposes that vary with the context. Generally speaking, the citations in *In de caelo* 2.10–12 are roundly critical. No opinion attributed to Alexander save the one at 472.8–15 is accepted: in the main, the citations of Alexander and their criticism give the impression that Alexander is an exegete of modest philosophical and technical acumen. Indeed, even the exception occurs not because Alexander solves the problem at hand but because his remark facilitates Simplicius' presentation of Aristotle's 'true' meaning. To see this, let us review these citations in turn.

On Teleology

After laying out Aristotle's explanation in 2.10 of why the planetary motions do not exhibit the expected proportionality, Simplicius wonders whether it actually helps to suppose that the sphere of the fixed stars dominates

¹ See, e.g., 112n12, 113n13.

² See 101n22.

the planetary motions beneath it in inverse proportion to their distance. The problem is that this idea entails that the planet's motions are both forced and contrary to nature [472.4–7]. To address this, Simplicius cites Alexander [472.8–15] for his remark that the diurnal motion of the sphere of the fixed stars is responsible for the inversely proportional decrease in eastward motion of the planets below, and that this is something which the planets desire out of recognition that it makes for the best arrangement of the cosmos. In this way, for example, Saturn's eastward motion is construed to be the coincidence of necessity *and* final causation.³

Curiously, Alexander's remark is not deemed to be apt, even when supplemented with Simplicius' reminder that circular motions do not have opposites and, thus, that the motion imposed on the planets by the sphere of the fixed stars cannot be contrary to their nature [472.15–20]. For, as Simplicius goes on to explain [472.21–473.7], the crucial issue is that each planet in so far as it is ensouled and capable of action must have a *proper* motion, that is, a motion which springs unimpeded from its nature and which advances according to that nature without resistance or diminution. Saying that the planetary motions are forced but still voluntary hardly helps. What Simplicius wants instead is a statement of what the proper motions of the planets are and how the proportionality of their periods is rooted in this.

Yet, the citation of Alexander is useful in that the mention of teleological considerations brings to the fore the nature of what is in motion and opens up the prospect of an explanation of the proportionality on the basis of what this nature is. More specifically, Alexander opens the way to a causal account of the celestial motions of the sort that Simplicius wants, that is, an explanation of how the heavenly bodies move that presents these motions as consequences of what they actually are. For Simplicius, though Alexander addresses the question at hand 'quite well', he does not go far enough: the answer, and thus Aristotle's meaning, lies for him not in the mere fact that the planets are rational agents but in the blending of the motions constituting the natures of these rational agents [473.7–474.6].

³ As noted previously, Alexander's *In de caelo* is not extant today. Still, one may consider this report in the light of his *Quaestiones* 1.1 and 1.25 [Bruns 1887, 2.20–4.26 and 39.9–41.19 (translated in Sharples 1992, 16–19, 82–86)] and the *Mabādi'*, an Arabic translation of his otherwise unknown *Περὶ ἀρχῶν τοῦ κόσμου* [Genequand 2001].

On the Isodromic Planets

The next citation [474.7–13] reports Alexander's conviction that the planets thought to share the same period are proof that larger spheres move faster by nature and that the sphere of the fixed stars retards the planetary motions eastwards in inverse proportion to their distance from it.⁴ But rather than explicating now what Alexander meant in saying that larger spheres are faster by nature, Simplicius concentrates on his assertion that the isodromic planets are Mars, Mercury, and Venus, with Mercury situated above Venus [474.14–28]. As he sees it, there is either a scribal error in his text of Alexander or Alexander is following an antiquated account of the order of planets; and so he dismisses the argument.

This citation allows Simplicius to broach a real problem for any attempt to discern proportionality in the planetary motions or periods. Moreover, beyond raising the problem of planetary isodromy, this citation of Alexander is noteworthy because in arguing that it does not itself merit serious consideration, Simplicius draws on Ptolemy to correct Plato.⁵

On the Motion by Nature of Larger Spheres

After discussing the flaws in Alexander's argument from planetary isodromy, Simplicius turns to another of Alexander's claims, namely, that planets near the sphere of the fixed stars return more slowly because their spheres are larger [474.30–32]. This claim, as Simplicius realizes, seemingly amounts to another explanation of the proportionality of the planetary motions, one that proceeds without mentioning the sphere of the fixed stars and its dominance.

Alexander's thesis is about the planetary sidereal periods, that is, about the fact that these periods increase with distance from the center of the Earth. Now, a key consequence of this proportionality of these periods to the planetary distances from Earth is that their *linear* speeds or, equivalently, the distances that each travels along its circular path in a given time interval, are the same.⁶

For his part, Simplicius is no kinder to this argument than he was to the one from isodromy. And rightly so. As Simplicius notes, Alexander's solution fails because it takes as a premiss what is unknown, the relative sizes of the planetary spheres [474.32–475.8].

⁴ Cf. 495.23–29 with Comment 12.18, pp. 268–269.

⁵ On Simplicius' reliance on Ptolemy, see also pp. 84–86.

⁶ Cf. Comment 10.14, pp. 213–214.

On a Circular Argument

Alexander is cited but once in Simplicius' commentary on 2.11. The issue is whether there is a circularity vitiating Aristotle's argument in *De caelo* 291b11–17 that the heavenly bodies are spherical because they do not move of their own accord and his argument in 2.8 that these bodies do not move of their own accord because they are spherical [477.24–27.] Simplicius reports that, for Alexander, there is no circularity because the conclusions in both arguments are demonstrated by means of other considerations too [477.27–478.3]. Simplicius then demolishes this peculiar contention: as he observes, the claim that the demonstrations of these two propositions are circular is independent of the existence of other proofs for each.

This time, however, the citation of Alexander, though unavailing in its own right, frames Simplicius' own suggestion that, for Aristotle, the two propositions—that the heavenly bodies do not move of their own accord and that these bodies are spherical—are convertible. In this way, Simplicius defangs the charge of circularity [478.8–14], saves Aristotle, and incidentally impugns Alexander once more as an interpreter.

On an Ellipsis

The first citation of Alexander in *In de caelo* 2.12 [481.22–24] is a clear instance in which Simplicius goes out of his way to abuse him. Alexander's contention seems to have been that Aristotle's encouragement at *De caelo* 292a14–17 that it is good to pursue answers to the two leading problems of chapter 2.12 is expressed elliptically because the basis on which such inquiry is reasonable is not given until 292a18–22 and elaborated subsequently to that.⁷ So far as the substance of the claim goes, Simplicius would seem to be in agreement [481.26–30]. What he objects to is the charge that Aristotle writes elliptically rather than concisely [481.25–26]. But this is in truth a silly quibble: ellipsis is a pervasive feature of Aristotle's prose.

On the First Problem of 2.12

The next citation [485.5–10] is more positive: Simplicius reports, and apparently accepts, Alexander's outline of Aristotle's response to the first problem in 2.12. Still, he *does* suggest that there may be a further distinction in play [485.10–12].⁸ Simplicius then sets this further distinction out in detail

⁷ See Comment 12.04, pp. 226–227.

⁸ See Comment 12.06, pp. 229–230.

[485.12–29] using late Platonic concepts which are presumed relevant because of a passage purportedly in Aristotle's *On Prayer*.⁹

On the Four Elements

In drawing his discussion of the first problem to a close, Simplicius takes up Alexander's claim that the four *sublunary* elements are without soul and do not act [489.12–13]. This claim is not strictly relevant to the first problem, regardless of whether the aetherial element of which the heavenly bodies are composed is the unique fifth element proposed in the *De caelo* or a blend of pure forms of the four sublunary elements in which fire (*qua* light) predominates. But, to Simplicius who regards aether as such a blend, this argument may still have posed a threat. After all, is it really reasonable to suppose that this purified, supralunary blend has soul when the sublunary simple bodies of the same kind do not? In any event, the claim merited refutation at this juncture. What is noteworthy, however, is that, though Simplicius supplies one at some length, it is more rhetorical and demeaning than demonstrative [489.13–21]. Indeed, much of refutation amounts to little more than the question, 'How ever could one think something so preposterous, given that ...?'

In refuting Alexander, Simplicius points to the fact that the total amount of each element in the universe is eternal, and casts Alexander's claim as the outcome of the theses that what is simple cannot have soul, and that what is always in motion in the same way does not act. After disposing of these two theses, Simplicius imagines that Alexander would accept an obvious consequence of his position, namely, that the Earth lacks soul because it does not move, a consequence which Simplicius then disparages [489.22–30]. Thus, in setting himself against something that Alexander reportedly held as well as something that he might have been led to think given his reported views, Simplicius effectively maintains that it *is* reasonable to suppose with Aristotle that the heavenly bodies are alive and act. Whether the further claim that the sublunary simple bodies and, especially, Earth, are ensouled and rational is an entailment of this or something more Simplicius does not clarify. At the same time, in adopting polemic rather than offering reasoned argument, he does not accord Alexander much respect.

⁹ See 130n82.

On a Lexical Matter

There was, it seems, a debate among commentators about the logical relation of *De caelo* 292b15–30 and 292b30–293a4. Alexander is cited as one who thought that the passages present independent arguments, putatively because he thought that the demonstrative «ἥδε» ('this': 292b30) has «θέσις» ('position'), «τάξις» ('order') or «ἀνισότης δοκοῦσα» ('apparent inequality') as its referent [491.1–2]. Simplicius, who for his part (correctly) thinks that the passages constitute a single argument because «ἥδε» picks up «ὑπεροχήν» ('superiority': see 292b29), notes that if Alexander is right, there is a large lacuna in the received text. But either way, Simplicius is clear that there is no real problem for Aristotle's exposition [491.3–11].

Alexander and Porphyry

Simplicius' final citation of Alexander in commenting on 2.12 reports that both Alexander and Porphyry expressed dismay in their lectures on *Meta.* Λ that there was no good account of how Aristotle gets a total of 47 spheres in all [503.32–34]. This reference to leading thinkers inside and outside the school of late Platonic thought respectively, emphasizes the difficulty that scholars have had in making sense of *Meta.* 1074a12–14. This apparently serves in part to justify in turn Simplicius' decision to limit himself to a review of the *status quaestionis* [503.10–32, 503.35–504.3] instead of developing his own interpretation.¹⁰ Granted, he may already have inclined to limiting his comments in this way: after all, the thesis that no astronomical hypothesis as such is demonstrably true would presumably chill his enthusiasm to address this vexed question in the first place. In any case, I surmise, for Simplicius the philosopher, no vindication of Aristotle is required when the details of his argument are so dependent on astronomical theory.

Conclusion

In his commentary on 2.10–12, Simplicius' citations of Alexander at 472.8–15 (teleology), 477.27–478.3 (circular argument), and 485.5–10 (first problem) serve to frame Simplicius' own interpretations. The first is especially important because the interpretation framed [473.7–474.6] is essential to Simplicius' response to Philoponus. The first two citations, however, come at some expense to Alexander's reputation as an interpreter, given that in the former what is reported is not in itself relevant and that in the latter it is fallacious. In the third citation (four elements) and with the same result

¹⁰ See Comment 12.23, pp. 273–277.

so far as Alexander's standing is concerned, Simplicius uses him [489.12–13] as a foil to save Aristotle by defending the reasonableness of supposing that the heavenly bodies are ensouled and rational [489.13–30].

In contrast, the citation of Alexander and Porphyry at 502.32–34 highlights the difficulty of interpreting Aristotle's text, and tends to excuse Simplicius from any duty to develop a satisfactory account of his own.

The citation at 474.7–13 (isodromy) does present the one instance in the commentary on these chapters in which Simplicius turns to Ptolemy in preference to an antiquated Plato. The citation at 474.30–32 (larger spheres) appears to have a wholly negative function: it shows little more than that Alexander is not sharp when it comes to technical or mathematical matters. Likewise, the citation at 491.1–2 (lexical matter) does not reflect all that well on Alexander's skill in reading Aristotle's Greek.

The citation at 481.22–24 (ellipsis) is just dyspeptic. Indeed, as the extreme in a noticeable trend in Simplicius' citations of Alexander in *In de caelo* 2.10–12, I do wonder if this unflattering treatment of Alexander is not in fact payback for mischief.¹¹ After all, for Simplicius, Alexander 'misread' Aristotle by insisting that the natural motion of aether was about the center of the cosmos rather than about *a* center, and so supplied Philoponus with the fuel to attack Aristotle by arguing that this entails a view of the planets and how they move which is inconsistent with observational evidence and current astronomical theory.¹² At least, it makes sense if one allows that the *real* burden of the commentary on 2.10–12 is the *apologia* at the end of *In de caelo* 2.12 itself.

Eudemus of Rhodes

Eudemus,¹³ though cited often in Simplicius' commentary on Aristotle's *Physica*,¹⁴ appears only four times in the *In de caelo*. In general, these citations allow Simplicius to elaborate a theme that is fundamental to his interpretation of the *De caelo* and to distinguish Aristotle from other leading figures in the early history of Greek thought.

¹¹ Cf. 377.24–25 κακοσχόλως πως.

¹² 32.1–11, 32.12–16. See Comment 12.27, pp. 284–288.

¹³ See g8n10.

¹⁴ Eudemus is for Simplicius a reliable 'co-worker': see Falcon 2012, 167. For discussion of Simplicius' citations in his *In phys.* of Eudemus, see Baltussen 2008, 99–104.

On Anaximander

In the first instance [471.4–6], Eudemus is cited for the claim in some unnamed text that, while Anaximander was the first to come up with an account of the planetary sizes and distances, the Pythagoreans were in fact the first to establish the order of these planets. This citation validates Aristotle's turn in 2.10 to a new source of information, texts in astronomy, when theorizing about the heavens, since, as Simplicius remarks, the order of the planets (*scil.* their sizes and distances) has been demonstrated in these works [471.1–4]. The point, in other words, is not that Anaximander and the Pythagoreans offer the best account of the planetary sizes and distances—Simplicius is aware of Ptolemy and his *Hypotheses planetarum* and even mentions that Ptolemy perfected what Anaximander and the Pythagoreans first proposed [471.6–11]—but that this was the sort of thing that Aristotle had in mind. This citation, incidentally, suggests that, in pondering the proportionality of the planetary sidereal periods, Aristotle was obliged to rely on work in astronomy that was subsequently rendered obsolete.¹⁵

Eudemus with Sosigenes

The second citation [488.18–24] is complicated by a citation of Sosigenes,¹⁶ so I will treat them together. In this passage, Simplicius indicates that he is drawing on a work by Eudemus of at least two books that was entitled *Astronomical History* [488.19–20]. Whether he had this text in hand rather than some digest or selection of its contents is undeterminable. Further, it is conceivable that his access to Eudemus was actually through Sosigenes.

The substantive claim attributed to Eudemus is that Eudoxus was the first of the Greeks to develop astronomical hypotheses by which the phenomena of the planetary motions could be saved. Sosigenes, Simplicius tells us, apparently followed Eudemus in this and added the claim that it was Plato who first issued the challenge to save the phenomena by way of hypotheses in which the motions of the heavenly bodies are assumed to be smooth, circular, and ordered.

The question of the historicity of these two claims is much discussed and still controversial. For my part, I do not find the claim about Eudoxus as understood by Simplicius particularly cogent because there are other equally credible reconstructions of what might underlie *Meta.* A.8. And so

¹⁵ The emphasis on 'firsts' is, I expect, Eudemian since it is irrelevant to Simplicius' purposes.

¹⁶ See 136nn18.

far as the assertion about Plato goes, I regard this formulation of the Platonic challenge as an anachronism.¹⁷ Indeed, I would urge that the assertion about Plato is better seen as an expression of the effort by later Greek intellectuals to characterize the massive impact that Plato had on subsequent thought, perhaps on the basis of isolated passages in his dialogues.¹⁸

Such historical issues aside, however, it is very important to understand the thrust of Simplicius' citation. At its narrowest, it serves to buttress his contention that the development of astronomical hypotheses to account for the planetary motions is the consequence of a common failure to identify their real motions by connecting these motions to their substantial nature, and thus to distinguish properly what is real and what is apparent in the observations of the planets [488.7–18]. As Simplicius would have it, this kind of astronomical theorizing, although profoundly misguided, had a noble lineage, its first practitioner being Eudoxus. Moreover, as a form of inquiry, it was thought to go back to Plato who first formulated a challenge which, as Simplicius intimates, set the course for subsequent theorizing about the heavens.

Of course, it does not follow for Simplicius that Plato set such theorizing in motion for the same reasons that others pursued it. Indeed, as I have indicated in Chapter 3, Simplicius himself appears to have thought that Plato's challenge was actually misunderstood by those who attempted to meet it by devising planetary hypotheses.

But, in any event, the most that Simplicius has to allow on this score is that Plato gave voice to a program of research suited to, and welcomed by, those like Eudoxus who were incapable of addressing the question of the planetary motions within a proper physical theory. Here, then, we find implicit a critical evaluation of Eudoxus' contribution and in fact of any account of the planetary motions by astronomers.

Moreover, according to Simplicius, such theorizing was the context in which Aristotle solves the first of the two problems in 2.12, since, as he says, Aristotle took for granted the plurality of motions which were to be saved or accounted for by using hypotheses [488.3–9]. But this does not mean that Simplicius regards Aristotle as one of those who cannot distinguish the real and the apparent in the motions of the heavenly bodies and so are unable

¹⁷ See Comments 12.07 and 12.09, pp. 230–248 and 251–259.

¹⁸ See, e.g., Zhmud 1998. The idea that Plato was the director or even architect of subsequent thought, particularly in the sciences, has been the subject of study and debate since the 19th century, most of it highly speculative.

to grapple with how the observed motions are explained by real motions deriving from the nature of the heavenly bodies—which is all to the good, given the *De caelo* itself.

So viewed, then, this citation of Eudemus and Sosigenes initiates Simplicius' disengagement of Aristotle from a reading of the *De caelo* that a polemicist like Philoponus might urge, a disengagement completed in the great digression at the end of *In de caelo* 2.12. Given this much, however, we can discern the outlines of a critical thread in the *apologia*. If Simplicius sees Aristotle as a proponent of the sort of physical theory needed for understanding the planetary motions, and if he thinks that Aristotle still took for granted the planetary stations and retrogradations and even adopted homocentric planetary hypotheses, it would seem to follow that, for Simplicius, chapter 2.12 is a *provisional* exercise made in an effort to advance physical theory.

Indeed, he would surely be right in this. After all, the two problems of 2.12 are matters that anyone who has followed the demolition of the Pythagorean thesis of cosmic ἀρμονία might still raise and as such these problems should be answered on commonly held terms. In the present instance, this would entail supposing (but not necessarily accepting) that the planets do indeed make all the observed motions as well as introducing as heuristic premisses claims (such as that the celestial bodies are ensouled and act) which are in fact presented elsewhere as doctrine.¹⁹

On Callippus

The third and fourth citations of Eudemus are like the citation of Anaximander in that they each lack mention of a text and concern technical points in astronomy proper.²⁰ In the third, Simplicius cites Eudemus to clarify why Callippus added two carrying spheres to the hypotheses for the Sun and the Moon [497.17–22]. The fourth [497.22–24] concerns Callippus' addition of one carrying sphere to the hypotheses for Mercury, Venus, and Mars. Here Simplicius cites Eudemus either to say that there *was* a reason which is left unstated (or missing) or to report that Eudemus did not in fact indicate Callippus' reasoning.²¹

¹⁹ See 97n5 and Comment 12.05, pp. 227–229.

²⁰ These three citations may well be taken from a book, perhaps the *Astronomical History* mentioned at 488.19–20 or the work by Sosigenes that Simplicius is drawing on, to mention but two possibilities.

²¹ See 154n213. Both citations are qualified in an interesting way. As Simplicius says, the third is stated concisely (συντόμως); and the fourth, concisely and clearly (συντόμως καὶ σαφώς). Though Baltussen [2008, 101] interprets these adverbs in Simplicius' citations

The lack of technical detail in these citations is a sign, I take it, that Simplicius is writing with an eye on the divide between Aristotle and those who cannot distinguish appearance and reality in the motions of the heavenly bodies and who are thus unable to account for what one observes by way of motions that are not only smooth, circular, and ordered, but also derive from the substance of the bodies themselves. What is important here, apparently, is that Callippus and Eudoxus are seen to belong in the latter group: the details are not required.

Conclusion

Eudemus, though cited but a few times, is still an important player in Simplicius' roster of sources for his commentary on the *De caelo*. Simplicius uses him as an authority in driving a wedge between the homocentric hypotheses of Eudoxus/Callippus and Aristotle's talk of the planetary motions in *De caelo* 2.12 and *Meta.* Λ.8. As Simplicius has already indicated [see 32.12–29], Aristotle's elaboration of these hypotheses is provisional or heuristic and need entail no commitment.²² The citations from Eudemus contribute to this segregation of Aristotle.

Claudius Ptolemy

The three citations of Ptolemy in *In de caelo* 2.12 confirm what is manifest earlier in the commentary, that Ptolemy is Simplicius' leading authority in matters of mathematics and technical astronomy.²³ In 471.9–11,

the sizes and distances of these [planets] have been made more precise by those who come after Aristotle and quite perfectly so by those associated with Hipparchus, Aristarchus, and Ptolemy

of Eudemus in the *In phys.* as bearing on Eudemus' attempts to clarify Aristotle's *Phys.* by recasting it, this does not seem to be the case here. After all, as Simplicius says in prefacing the third citation, there is no surviving treatise by Callippus and Aristotle does not address the point at issue. Here, then, it would seem, 'concisely' amounts to 'without detail' and lacks any presumption of summarizing or recasting a written text. Indeed, given «ιστόρησε» and «λέγειν γὰρ αὐτόν φησιν» at 497.17–18, it would seem possible that Eudemus is reporting a remark by Callippus that he has heard either directly or indirectly. The same, I think, is true of both adverbs in the fourth citation: regardless of whether the reason was given by Eudemus but left unstated by Simplicius, or stated by Simplicius and missing in a lacuna, or not given by Eudemus in the first place, the citation does not require that Eudemus had a written text before him.

²² See Comment 12.27, pp. 284–288.

²³ See Comment 12.37, p. 296.

Ptolemy stands as the last of those living after Aristotle who have improved on the values for the sizes and distances of the Moon, Sun, Mercury, and Venus. In fact, Ptolemy (along with the Hipparchans²⁴ and Aristarchus) is said to have made them perfectly precise. The same general point is made when Simplicius cites Ptolemy again at 474.26–28. Here Ptolemy's nesting hypothesis for the planetary spheres of the Sun, Venus, Mercury, and the Moon is adduced in the criticism of Alexander on isodromy.²⁵ At 510.19–23, by the way, this nesting hypothesis is explicitly embraced.

With Simplicius' comment at 471.9–11, one should recall his earlier remark that Ptolemy disregarded earlier (homocentric) accounts of how the heavens move and proposed to save the phenomena by positing a system of homocentric spheres in which eccentric and epicyclic hypotheses are embedded, a system of planetary hypotheses that plainly ignored any strict requirement that the heavenly bodies have circular motions centered on the Earth.²⁶ In this way, Ptolemy is emphatically placed at a stage in the development of astronomy which is far beyond what the science was in Aristotle's time. This is further reinforced in the third citation [506.16–22] when Ptolemy attacks the very idea of using unwinding spheres,²⁷ and adds weight to Simplicius' own criticism of the homocentric hypotheses.

One should recall as well that Simplicius has already acknowledged in another context that there has been progress in astronomy since the time of Aristotle, progress which he rightly connects to Ptolemy:

But inasmuch as Ammonius, our Head,²⁸ observed Arcturus in my presence in Alexandria through a solid astrolabe²⁹ and found that it had changed in respect of its position as given by Ptolemy by the amount which was required in that it moved [in the direction opposite to the daily rotation] one degree in 100 years,³⁰ it would perhaps be truer to say that the starless sphere, which contains all [spheres] and of which there was not yet knowledge, so it seems, in Aristotle's time, by performing this single, simple motion from the east brings the other [spheres] round [with it];³¹ that the [sphere] which is called

²⁴ See Comment 10.07, pp. 206–207.

²⁵ See Comment 10.13, pp. 211–213.

²⁶ 32.23–28. See Comment 12.27, pp. 284–288.

²⁷ On this attack and its complexities, see Comment 12.25, pp. 278–283.

²⁸ 462.20 *καθηγεμών*: *scil.* the Head of our school. See 3n2.

²⁹ 462.21 τοῦ στερεοῦ ἀστρολάβου: *scil.* an armillary sphere.

³⁰ 462.23 ἀντικινούμενον: Simplicius would appear to be following Ptolemy in presenting this observation as one of stellar precession. Otto Neugebauer [1975, 1037] notes that Ammonius' observation purportedly confirming Ptolemy's value for precession was in fact in error by an observable 2;50°.

³¹ 462.24–26: the starless sphere is responsible for the daily rotation; the sphere of the fixed stars makes a full rotation in the opposite direction in 36,000 years.

fixed by us performs two motions, one which is of the whole from the east and its proper motion from the west; that the heavenly bodies in [the fixed sphere perform] these two [motions] as well as their proper rotation; and that the successive spheres and the [planetary] bodies in them likewise [perform respectively] the same two and the same three motions. [462.20–31]

Ptolemy, who is presented as the pinnacle in a technical science that had progressed on several fronts since the time of Aristotle, thus serves as the leading authority in a discipline ancillary to physical theory. The very fact that he has authority, that his views are to be noted and embraced, is, however, tempered by the realization that his expertise will likely be superseded and, at any rate, does not include giving the true account of the planetary motions. Thus, at the close of his *apologia*, when he rescues the second problem of 2.12 and accepts the planetary nesting hypothesis earlier ascribed to Ptolemy, Simplicius shows himself to be in the same position as Aristotle: as he must turn to Ptolemy, so Aristotle turned to Callippus.

Sosigenes

In addition to the citation of Sosigenes in 488.18–24,³² there are 10 other occasions in which Simplicius explicitly names Sosigenes. The question of how much to include in these citations is controversial and I will add nothing here beyond what is proposed in the notes to my translation—in short, a conservative determination of what one absolutely *must* ascribe to Sosigenes, given the Greek itself.

Nevertheless, it will, I presume, be agreed on all sides that these citations are taken from a single, unnamed work.³³ Equally clear is that this work included explication and criticism of the homocentric hypotheses laid out in Aristotle's *Meta.* A.8 as well as criticism of astronomical hypotheses rival to them [see 509.26–28, 510.24–26].

Now, Sosigenes, though a Peripatetic philosopher and the teacher of Alexander, was writing at a time when the epithet 'Peripatetic' meant only that one read and respond to Aristotle and not, as Alexander would later insist, that one accept and defend Aristotle's views. The aim of the work that Simplicius draws on was, apparently, to clarify the ancient and more recent planetary hypotheses by examining critically the claim that they do in fact save the phenomena [510.26–31].

³² See pp. 81–83.

³³ On the claim that Proclus gives the title, see Comment 12.08, pp. 248–251.

This book proved of substantial value to Simplicius, especially because it included:

- an explication of the theory presupposed by Aristotle's unwinding spheres,³⁴
- a discussion of the very puzzling assertion at *Meta.* 1074a12–14 that if one does not add the spheres for the Sun and the Moon, there will be 47 spheres in all,³⁵
- a lexical remark [504.4–9] that makes sense of the terminology used by Aristotle and Theophrastus,³⁶
- criticism of the homocentric hypotheses [504.17–20] which Simplicius elaborates,³⁷ as well as
- criticism of the eccentric and epicyclic hypotheses³⁸ that suits Simplicius' view that none of the hypotheses offered to date may actually be the case.

In other words, the citations of Sosigenes serve Simplicius' need to rationalize why he and other late Platonists prefer hypotheses of the sort found in Ptolemy's works to the homocentric hypotheses of Aristotle. Moreover, the fact that Simplicius uses this work suggests that Sosigenes managed all this without drawing any broader conclusions about how the inadequacy of the homocentric hypotheses bears on the central themes and argument of the *De caelo*. At least, there is no sign that Sosigenes' criticism was perceived by Simplicius to undermine late Platonism.

CODA

In the preceding chapters, I have endeavored to show that one of the guiding aims in *In de caelo* 2.10–12 is to vindicate the late Platonists and their faith in the ultimate value of reading Aristotle. In this Chapter, I have indicated numerous ways in which Simplicius marshals diverse literary sources to facilitate this fundamental aim. Moreover, I have in various Comments indicated that Simplicius' history of astronomy from the time of Aristotle to his day (or better, to the time of Ptolemy, when for Simplicius it seems

³⁴ See 498.1–10, 498.10–499.1, 499.16–501.11, 501.12–21, 501.22–26, 501.26–502.19, 502.19–27.

³⁵ See 503.29–32, 503.35–504.3.

³⁶ On Simplicius' reliance in his *In phys.* on Theophrastus, see Baltussen 2008, 91–99.

³⁷ See 504.20–505.19. I will return to this in the Coda to this Chapter.

³⁸ See 509.26–28, 510.24–26.

to end) is not possible on empirical grounds. I have also attacked here and elsewhere that historiography which presumes to correct Simplicius in the hope of getting to the historical truth: in my view, what this historiography offers instead with its judgments of what seems likely and so forth is nothing more than the unseemly comfort of reading oneself into the past. Further, if we reflect on how Simplicius actually reads the past, using him to reconstruct the history of astronomy will seem no less foolish than relying on him to interpret Aristotle. In short, I do not agree that in their analyses of Simplicius' commentary on *De caelo* 2.12 Schiaparelli and his more recent intellectual epigony reach any valid insight into the history of astronomy in the fourth and third centuries BC.

As I see it, the question is not, 'What does Simplicius tell us of the history of earlier astronomy *per se*?' Rather, the question should be, 'How does his narrative stand in relation to contemporary and earlier accounts of the history of astronomy?' The challenge is to understand each account on its own terms and to determine its interactions with the others, if there are any.

Now, that there were rivals to Simplicius' narrative is apparent when Simplicius reports that Nicomachus and Iamblichus attribute the first eccentric planetary hypotheses to the Pythagoreans [507.12–14].³⁹ Moreover, even a brief survey of Pliny's *Nat. hist.*, Theon's *De util. math.*, and Proclus' works, for example, reveals divergent accounts of who did what and why in astronomy.

In addition, it is also evident that elements of Simplicius' account were already in place. Thus, for instance, though the elaboration in 504.20–505.19 of the claim that all the heavenly bodies vary in their apparent size (brightness) may well be due to Simplicius, the claim itself underlies Philoponus' polemic in 32.9–11. Further, the more limited (and yet still false) thesis that the Sun is visibly larger at perigee is attested in earlier Platonizing literature.⁴⁰ Likewise, the values for the synodic and sidereal periods that Simplicius records are taken from some source, not Ptolemy however, perhaps with an eye to Plato's *Timaeus*.

My aim in raising this question of narratives is not, of course, to reinstate the usual *Quellenforschung*. In the first place, any talk of rival narratives and borrowed elements should be limited to texts in hand. Only in this way may

³⁹ See Comment 12.39, pp. 297–298.

⁴⁰ See, e.g., Theon, *De util. math.* 3.26, 3.30 [Hiller 1878, 156.20–157.12, 164.14–17, 173.5–9]; Proclus, *Hyp. ast.* 7.13–15. It would certainly be worthwhile to track this claim, so far as one can, to its origins and then to consider the vastly more interesting question of its persistence—much as one should with the equally absurd story of Pythagoras' discovery of the ratios of the musical concords.

we avoid overlooking the fact that the construction of Simplicius' *apologia* was not a simple matter of compiling such elements but a creative act requiring deliberation and designed to address an unprecedented challenge. Thus, the more conservative view urged here of the extent of Simplicius' explicit citations coheres with reinstating Simplicius as an apologist and historian, and with the requirement that claims about his debts be made in the light of positive evidence, not the fuzzy expectation that he was drawing surreptitiously on some source. The measure of true scholarship, after all, should be what it can demonstrate, not what it can believe. Consequently, while the idea that the homocentric account in *Meta.* Λ.8 is intended to account for planetary stations and retrogradations appears to have been held by Sosigenes [504.16–20], any ascription to Sosigenes of the details of this theory [493.11–497.24] and of its criticism [504.20–505.19] is, as I see it, unwarranted at this time. Indeed, one should remember that astronomy was a subject of considerable interest to the late Platonists and that it is hardly outlandish to suppose that Simplicius is himself responsible for much of the technical content of his *apologia*, mistakes and all.⁴¹

To be sure, there is more to be said about Simplicius and the history of astronomy. But that belongs to another project. The challenge in pursuing it will be to get past the kind of historiography exemplified in modern accounts of homocentric planetary theory. What is needed is historiography which does not suppose that the history of astronomy is but a record of observations, parameters, and mathematical techniques, and which steadfastly declines to supplement such a record with an antiquated *Quellenforschung* fallaciously enhanced by mathematical inference.

⁴¹ See, e.g., 462.20–31 [pp. 85–86]. On the late Platonist engagement with the *Almagest*, see Pingree 1994.

CHAPTER FIVE

CONCLUSION

It was a time of Christian intolerance and persecution when Simplicius wrote his commentaries. Even the relief afforded him by fleeing beyond the reach of the Christian Empire was made bitter by the need to meet the attack on his Platonism mounted by his apostate colleague and now Christian philosopher, John Philoponus. The cause of dispute was Aristotle's argument that the cosmos is neither created nor perishable but eternal. At issue, in particular, were the arguments in *De caelo* 1.1–4 that the heavens are constituted of a fifth simple body, aether, which is itself imperishable in that its only form of natural change is locomotion in a circle about the center of the universe.

In Philoponus' attack, questions about the existence and nature of this fifth simple body were coupled with the remark that aether so construed can only warrant accounts of the planetary motions that are inconsistent with current astronomical theorizing. And so, to defend his faith that the cosmos is not created in time but eternal, Simplicius was obliged to defend his reading of Aristotle, a reading which both justifies and is justified by this faith. But his defense involved more than merely detailing Philoponus' failure to grasp Aristotle's meaning; it also entailed Simplicius' addressing the unpalatable—that, while he endorsed the Aristotelian argument that the motions of the heavens are by nature smooth, circular, and ordered, he agreed with Philoponus in rejecting the homocentric-geocentric account of planetary motion found in Plato's *Timaeus* and developed by Aristotle in *Meta.* A.8, and in preferring an alternative account of the sort found in the works of Claudius Ptolemy.

The problem for Simplicius was complex and its solution is plainly crafted with an eye to its impact on his readers, his fellow Platonists. Philoponus' assault on the idea of aether is dispatched early in the commentary on book 1. The question of planetary motion, however, is postponed to the commentary on 2.10–12, a part of the *In de caelo* in which Philoponus is not mentioned at all. So far as this motion is concerned, the core of Simplicius' defense comes in a concluding digression that exculpates the late Platonists from the charge of heresy to which they might seem liable by agreeing with Philoponus in following a more recent account of the planetary motions.

In this digression, Simplicius argues that the homocentric hypotheses expounded by Aristotle in *Meta.* A.8 are inadequate to the phenomena and that Aristotle was aware of this. Furthermore, he adds in historicizing the problem, there was at the time an effort to improve on them, albeit one that proved unsuccessful. But, as Simplicius also makes clear, though there may be numerous hypotheses purporting to save the phenomena, none is demonstrably the case. And, as he sees it, Aristotle was unique in his time for recognizing that the proper account of the planetary motions would have to come from physical theory and not astronomy. Nevertheless, so Simplicius notes, Aristotle does assume that the planets make more than two motions in 2.12. To explain this and the account of planetary motion in *Meta.* A.8, Simplicius follows Aristotle's turn in 2.10 to astronomical writings in answering philosophical questions about the planets and their motions, and casts Aristotle's treatment of planetary motion as provisional. That is, for Simplicius, Aristotle's acceptance of the *explananda* and the *explanantia* of homocentric theory was only apparent and not real because he was writing as a philosopher *qua* physical theorist addressing questions about the heavens by drawing on what was known or thought to be known of the heavens at the time.

By this reading of Aristotle, Simplicius averts Philoponus' polemic, rescues Aristotle's authority in the school of late Platonism, and upholds the value of the *De caelo* in its program of education. At the same time, Simplicius indicates that the late Platonists have no real commitment to the 'modern' planetary hypotheses, though following them is plainly the responsible course. Indeed, their situation proves to be the same as Aristotle's: since philosophical discussion of the heavens is to be constrained by astronomical observation and theorizing, then until astronomy is grounded in a proper physical theory of the planetary motions, reflections on the heavens in physical theory will be provisional or heuristic and not wholly demonstrative of unshakable truth. In this way, Simplicius also clears the path from Aristotle to Plato and, ultimately, to a divine understanding of both how and why the heavenly bodies move as they do which *is* unshakably true.

Simplicius' digression on astronomical hypotheses is not, I insist, a rubbish heap to be scavenged in the hope of discovering how Eudoxus and others must have conceived the planetary motions. Such a modern reading of Simplicius can only be described as a studied way of not reading, of failing to comprehend the text before one's eyes. Indeed, the great lesson of *In de caelo* 2.10–12 is its devising a historical framework and view of Aristotle to negotiate the tension between those values that give life its meaning with the hope of salvation and those that promote understanding of the world in which

life takes place. For Simplicius and Philoponus, there was no rift between these sets of values, no conflict of religion and science. For late Platonist and Christian alike, all these values were fundamentally religious, since they ultimately concerned God and entailed appropriate conduct over the course of a lifetime. From this perspective, Simplicius' Platonism is admirable and his commentary on *De caelo* 2.10–12 will reward study by any and all who can put aside the expectation that Simplicius conveys ancient astronomical theory whether wittingly or witlessly.

TRANSLATION

*Legere enim et non intellegere
neglegere est
(Disticha Catonis)*

IN ARISTOTELIS DE CAELO 2.10

291A29–B10¹

(Let us theorize on the basis of [works] on astronomy) about the ordering of the [heavenly bodies]² (—the way in which each moves³ in that some are prior and others posterior—and how they are related to one another in their distances, since it is discussed [in these works] sufficiently. It turns out that the motions of each are in proportion to their distances⁴ in that some [motions] are faster and some slower. That is to say, since it is supposed that the outermost revolution of the heavens is simple and fastest, and that the [motions] of the others are slower and more numerous—for each moves in a direction opposite to the heavens along its own circle—it is actually reasonable⁵ that the [body] nearest the simple and primary revolution goes through its own circle in the longest time, that the one that is farthest away in the least time, and that of the others the nearer always [goes through its own circle] in more time and the farther in less time. The reason is that the one nearest [the outermost revolution] is dominated [by it] most of all, whereas the one farthest [is dominated] least of all on account of its distance, and the intermediate [bodies are] actually [dominated] in the ratio of their distance,⁶) just as the mathematical scientists⁷ in fact prove.

Anyone making statements about the heavenly [bodies] also used to have [470.29]
to make statements about the ordering of the spheres and [planetary] stars
in respect of their position; [specifically, he used to have to say] which ones [470.30]

¹ See Comment 10.01, p. 201.

² *De caelo* 291a29 ἀντῶν: the antecedent is «τὰ ἄστρα» at 291a27. See Comment 10.02, pp. 201–202.

³ *De caelo* 291a30 κινεῖται: on the alternative reading «κεῖται» ('is placed'), see Comment 10.03, p. 203.

⁴ *De caelo* 291a31–32 κατὰ λόγον τοῖς ἀποστήμασι: «κατὰ λόγον» is qualified by a dative of respect. For both Aristotle and Simplicius, two magnitudes can be in a ratio only if they are of the same kind: cf. Euclid, *Elem.* 5 defs 4 and 5.

⁵ *De caelo* 291b3 εὐλογον (reasonable): for divergent interpretations of the significance of this term, see Bolton 2009, Matthen 2009, Leunissen 2009, and Pellegrin 2009. The question is whether such terms always introduce purely dialectical, *a priori* arguments or whether they sometimes indicate teleological arguments that are derived from what is observed perhaps in another domain.

⁶ *De caelo* 291b8–9 κατὰ λόγον τῆς ἀποστάσεως.

⁷ *De caelo* 291b9–10 οἱ μαθηματικοί: on this translation, see Comment 10.04, pp. 203–204.

- [471.1] are prior (that is, nearer the fixed [sphere]) and which ones are posterior (that is, nearer the Earth), and moreover, of course, how they are related to one another in respect of their distances (which are compared in reference to the Earth) on the basis of which the ratios of their sizes are in fact known.⁸ Thus, he says, regarding these matters ‘*let us theorize on the basis of [works] on astronomy*’,⁹ since proof has in fact been given there of the ordering of the wandering [stars], that is, [proof] of their sizes and distances—
- [5] Anaximander being the first to come up with an account of their sizes and distances, as Eudemus reports in attributing the ordering of their position to the Pythagoreans first.¹⁰ The sizes and distances of the Sun and Moon have been known until now by taking the means of their determination from eclipses¹¹—and it was reasonable¹² that Anaximander discovered these

⁸ 471.1 οἱ τῶν μεγέθων λόγοι: Simplicius contextualizes 2.10 by referring to an ancient concern about the sizes and distance of the *spheres* (or circles) on which the fixed stars and the planets move. Though he does write of the sizes of the Sun and Moon at 471.6, the issue for him is not what we call the magnitude or apparent size of a given fixed star or planet.

471.1 καταλαμβάνονται: see Comment 10.05, pp. 204–205.

⁹ 471.2: see *De caelo* 291a31–32. The text set in italics is a quotation of these lines from the *De caelo*. I will use this convention whenever Simplicius actually quotes the text of Aristotle.

¹⁰ 471.4: Anaximander of Miletus (sixth century BC, died after –546).

471.4–5: Hall [1971] suggests that, so far as Anaximander is concerned, the sizes and distances in question are those of the Sun and Moon only. But this is difficult, even if one assumes the same for the Pythagoreans, given that, both in what precedes and what follows, Simplicius is concerned with all seven planetary bodies. For what little they are worth, the ancient reports about Anaximander’s account suggest that he was thinking of the diameter of the rotating planetary rings of fire as well as of the diameter of the opening in these rings through which the fire is visible, Earth’s diameter being the unit of measure: see Kirk, Raven, and Schofield 1983, 135–136.

471.5: Eudemus of Rhodes (late fourth century BC), a younger contemporary of Aristotle, who may have been a candidate to succeed Aristotle as head of the Lyceum. On Eudemus’ writings on Aristotle’s *Physica* and Simplicius’ use of them, see Falcon 2012, 167; Baltussen 2008, 99–104. For discussion of Eudemus’ book on earlier Greek astronomy, see Bowen 2003a, 315–318.

471.5–6: the Greek would seem to mean that, in Simplicius’ view, Eudemus held that, while Anaximander was the first to raise and address the question of the planetary sizes and distances, the Pythagoreans were the first to give a correct account of their sequence [cf. Wehrli 1969, 121 *ad* fr. 146]. Timpanaro Cardini [1958–1964, 3.202–203], however, maintains that only the claim about the Pythagoreans comes from Eudemus.

¹¹ 471.6–8: as they are determined, for instance, in the third-century treatise *De magnitudinibus* by Aristarchus. This is not how Ptolemy computes the sizes and distances of the Sun and Moon in *Alm.* 5.13–16.

471.7 τὴν ἀφορμὴν τῆς καταλήψεως λαβόντα: «λαβόντα» (‘taking’) seems odd. Note Grosseteste’s ‘*occasionem assumptionis accipientes*’ [Bossier n.d.a, 141.1, reading ‘*assumptionis*’ for ‘*sumptiones*’] and Moerbeke’s more literal ‘*occasionem comprehensionis sumentes*’ [Bossier n.d.b, 448.9].

¹² 471.8 εἰκος ᾗν (it was reasonable): probably not to be read as ‘it is likely’ [so Mueller

[sizes and distances] too—and [the sizes and distances] of Mercury and Venus from their coincidence¹³ with [the Sun and Moon]. The sizes and distances of these [planets] have been made more precise by those who come after Aristotle and quite perfectly so by those associated with Hipparchus, Aristarchus, and Ptolemy.¹⁴ [10]

It turns out, he says, that the motions are in proportion to their distances because [planets] that are nearer the Earth, like the Moon, move faster, whereas those that are farther move more slowly in the proportion of their distances.¹⁵

Now then, this [claim], which was appropriately introduced in his account of the ordering, that is, of the distances, justifiably raised a problem: why the [planets] circling near the Earth move faster and the [ones] that are higher and come closer to the fixed [sphere] move more slowly, just as the [star] of Saturn which returns in position after 30 years [moves more slowly] than the Moon which makes a revolution in a month. In fact, the problem could be motivated from two [considerations]. [15]

First,] from size, since the larger body performs its proper motion faster, as Aristotle himself said,¹⁶ and since the containing body is always larger [20]

2005, 11]. Cf. Grosseteste's 'conveniens erat' [Bossier n.d.a, 141.1] and Moerbeke's 'verisimile erat' [Bossier n.d.b, 448.9–10].

¹³ 471.9: reading «παραβολῆς» rather than Heiberg's «μεταπαραβολῆς». See Comment 10.06, pp. 205–206.

¹⁴ 471.11: see 98n11.

471.11 τῶν περὶ Ἰππάρχου καὶ Ἀρίσταρχου καὶ Πτολεμαίου: on the translation, see Comment 10.07, pp. 206–207.

¹⁵ 471.12–14: Simplicius confuses Aristotle's position. For Aristotle, the motions and distances of the planets are proportional when the distances are taken from the sphere of the fixed stars. But Simplicius, perhaps out of his desire to speak of planetary distances and sizes as well, mistakenly assumes that the proportionality which Aristotle mentions holds when the distances are taken from (the center of) the Earth: see Comment 10.01, p. 201. Granted, there may be such a proportionality and the three worthies named in 471.11 certainly do construe planetary distances in reference to the Earth; but that is *not* what Aristotle meant. Nor does establishing one reckoning of this proportionality entail the other. Note that Themistius [*In de caelo B 10*] makes this confusion explicit by supposing that the proportionality holds with the distance from (the center of) the Earth [Landauer 1902, 118.8–12] and with the distance from the celestial sphere [Landauer 1902, 118.12–24].

¹⁶ 471.20: the claim that the larger body performs its proper motion faster is repeated in various forms at 474.7–8 (larger spheres are faster by nature), 474.30–32 (the upper spheres are larger and, therefore, have longer periods), 475.29–30 (the larger sphere is in fact faster), and 476.5–6 (larger bodies perform their natural motion faster). See Comment 10.08, pp. 207–208.

than the body contained. How, then, are the outer [motions] not performed faster in the ratio of their size or distance, but to the contrary are performed more slowly?

[25] Yet [second], the problem must also be raised from proximity or distance to the fixed [sphere]. For, if the fixed [sphere] performs the fastest motion of all the spheres, it is a consequence that the [bodies] nearer to it move faster than those that are farther in the ratio of their distance, I mean, that if the Earth is immovable by nature, the [planets] that come closer to the Earth would have to be slower than those at a greater distance and this again in the ratio of their distance.

[30] Now, in solving these problems handily, he says that, since the fixed [sphere] performs a single motion that is fastest (I mean, the motion from the east), whereas the wandering [stars perform] this motion as well as the one in the opposite direction, it would be reasonable that the [wandering star] nearest the fastest revolution¹⁷ goes through its revolution opposite to [the fastest revolution] in the most time because [this wandering star's revolution] is dominated and resisted by it,¹⁸ whereas the [wandering star] that is farthest¹⁹ moves faster than the others because it is dominated least of all on account of its distance, and that '*the intermediate [bodies] actually [move] in the ratio of their distance, just as the mathematical scientists in fact prove*'.²⁰

[5] What then? Do the [spheres] that come closer to the fixed [sphere] move more slowly because they are overcome by it? And yet, if [they move] by force, [they do] in fact [move] utterly contrary to [their] nature. Consequently, [the spheres] will perform both their motions, that is, the one from the east which they perform with the fixed [sphere] and the one from the west (that is, their proper motion) by force and contrary to [their] nature.²¹

¹⁷ 471.31–32: *scil.* Saturn.

¹⁸ 472.1 καὶ ἀντιχοπτόμενον (and resisted): Simplicius goes beyond Aristotle here and suggests an interaction between the sphere of the fixed stars and the planetary spheres.

¹⁹ 472.1: *scil.* the Moon.

²⁰ 472.2–4: the elliptical nature of Greek here allows Simplicius to preserve Aristotle's words while still adapting them to a slightly different thought.

²¹ 472.5–7: here as elsewhere in his commentary on *De caelo* 2.10–11, Simplicius follows Aristotle in supposing that each planet has but one sphere. See Comment 10.09, pp. 208–209.

Alexander²² confronts this problem quite well²³ when he says that the very fast motion of the fixed [sphere] is the cause of the slower return in position [10] for the sphere of Saturn, yet [that sphere] is by no means itself unwilling.²⁴ Indeed, it should choose and want this, since nothing would be better for [the spheres] or more worthy of choice than this sort of cosmic arrangement. Thus, both necessary causation and final causation coincide²⁵—since not only what is by force is necessary²⁶—that is, because it is best that it be so [the sphere of Saturn moves] willingly; but because [it] is close to the [sphere] that goes round in the opposite direction,²⁷ [it moves] out of neces- [15] sity.

Of course, their motions due to their influence on one another²⁸ are not for the [planetary spheres] contrary to nature, given that, because there is not an opposite, they do not have any motion that is contrary to nature.²⁹ Since all the motions which [the spheres] perform are according to nature

²² 472.8: Alexander of Aphrodisias, an Aristotelian commentator, became a public teacher of Aristotle's philosophy perhaps in Athens sometime during the period between AD 198 and 209. His commentary on Aristotle's *De caelo* has not survived. He was a student of Sosigenes (second century AD), a Peripatetic philosopher: cf. Hayduck 1899, 143.12–14; Bowen 2008c.

Simplicius is clear that Alexander's interpretations of Aristotle's arguments are good and even better than those of the other Peripatetics; but when it comes to arguments in which Aristotle criticizes Plato, he regards Alexander's accounts as dangerously wrong [see 377.20–34 and translation, p. 60]. Still, typically, Simplicius cites Alexander as a guide in clarifying the meaning of a passage as well as in rejecting other interpretations. It is worth noting, however, that in commenting on *De caelo* 2.10–12, though he cites Alexander often, Simplicius does this either to reject or to qualify what he takes to be Alexander's meaning. At no point does he simply accept what Alexander says [see pp. 74–80]. On Alexander's role in Simplicius' commentaries more generally, see Baltussen 2008, 107–134. On Alexander, see also Baltussen 2007, 271–273; Tuominen 2009, 21–24.

472.8–20: see fr. 155a in Rescigno 2004–2008, 2.277–284.

²³ 472.8 καλῶς δῆ: perhaps 'in an entirely correct way'.

²⁴ 472.10 οὐκ ἀκούσῃ μέντοι οὐδὲ αὐτῇ: cf. Denniston 1966, 196–197.

²⁵ 472.12–13: literally, 'the cause in accordance with what is necessary and the cause in accordance with what is best coincide'.

²⁶ 472.13 τὸ βίαιον (what is by force), not 'force' as Mueller [2005, 13] has it. Cf. Grosseteste's 'necessarium enim non violentum solum' [Bossier n.d.a, 142.17], where 'violentum' means 'an act of violence' and lacks the passive nuance that the Greek has in this instance, and Moerbeke's better 'necessarium enim non quod violentum solum' [Bossier n.d.b, 453.10–454.1]. See Comment 10.10, p. 209.

²⁷ 472.15 τῆς ἀντιστροφόμενης: *scil.* the fixed sphere.

²⁸ 472.15–16 αἱ ὑπ' ἀλλήλων κινήσεις: cf. 100n18. There is no indication in Aristotle's text thus far that the lower planetary spheres act on the celestial sphere or, for that matter, that there might be spheres other than the celestial sphere which act on lower planetary spheres.

²⁹ 472.16: this is argued in *De caelo* 1.4.

for them, it must be that some motions arise from [the spheres]³⁰ and others arise due to [the spheres'] influence on one another. Consequently, even in the case of the motion which [the planetary spheres] perform because they are moved with the fixed sphere, one should say the same thing, namely,
 [20] that not even this is contrary to nature for them.³¹

But perhaps the problem still remains.³² For let it be the case that their motions due to influence on one another are performed neither by force nor contrary to nature but willingly. Would it not be absolutely necessary³³ as well that the spheres have *proper* motions³⁴ according to nature, since they are ensouled and share in activity, as he himself will say?³⁵ But, if the
 [25] motions which they perform are two in number, the one from the east and the one from the west, inasmuch as [the planetary spheres] perform the motion from the east which belongs to the fixed [sphere] (given that they are carried round in this motion with it) and inasmuch as they also have the motion from the west which is itself dominated and resisted by the fixed [sphere], what proper motion can they have according to nature? Consequently, Aristotle's account has not solved the problems of how it is
 [30] still true that the larger body performs its *proper* motion faster; and of how what is close to the fixed [sphere] (which has the fastest motion) and is plainly more akin to it (since nearness in place has been assigned according to kinship in substance) has a slower motion, whereas what is next to the
 [473.1] immovable Earth has a faster one.

So, [Alexander]³⁶ has not, I think, solved these [problems]; rather, he has conceived another cause that does not finally get away from what is by force. That is to say, even if [the planetary spheres] have this derivative motion

³⁰ 472.18 ἐξ αὐτῶν: from the spheres, not from the motions as Mueller [2005, 13] would have it.

³¹ 472.18–20: by arguing that all the planetary motions are natural because there is no motion contrary to circular motion, Simplicius effectively argues that no planetary motion is forced, since all forced motion is contrary to nature.

³² 472.21 μήποτε (perhaps). As Baltussen remarks [2008, 127, 129], this adverb is typically a marker for Simplicius' own views and does not express real doubt: cf. 478.8, 481.24, 485.11, 88.30, 490.30, 510.19. At 480.19 and 491.10, «μήποτε» is better taken to mean 'never' or 'on no account'.

³³ 472.22–23: not 'Would it still really be necessary ...' [see Mueller 2005, 13].

³⁴ 472.23 οἰκείας κινήσεις: motions that are inherent or proprietary and, as Simplicius will make clear at 473.4–6, unimpeded.

³⁵ 472.23–24: see *De caelo* 292a20–21 ('we must suppose that they share in activity and life').

³⁶ Cf. Bossier [n.d.a, 143.15–16] prints the parenthetical remark 'Alexander videlicet sua superiori solutione solvit' in his edition of Grosseteste's translation, but reports in his *apparatus* that the phrase is not found in the codices.

from the east because they are moved with the fixed [sphere], nothing prevents them from performing this motion willingly because they also have their proper motion, that is, their motion according to a proper impulse [5] which is unimpeded³⁷ and proceeds according to nature, as if they were not even carried round with the fixed [sphere]. But if their *proper* [motion] (that is, [their motion] according to nature) is dominated as it is resisted, how will it be unforced?

[Forced it will be] unless someone should say that, in so far as they are akin to it, the [planetary spheres] which are near to the fixed [sphere] do themselves have as *proper* the motion from the east,³⁸ and that the larger [sphere] always moves faster in that its magnitude and speed of motion [10] are in the same ratio because there is a single union of all the spheres in a single heavenly body.³⁹ However, in so far as [these spheres] possess a nature that moves in the opposite direction, the ones that come under a little way to [the fixed sphere] perform the motion akin to [the motion of the fixed sphere] faster because they remain more in the peculiar character of the fixed sphere; whereas [they perform] the [motion] of the nature which [15] goes in the opposite direction more slowly⁴⁰ because they are not somehow constituted purely according to that [eastward moving nature]—just as the sphere of the Moon, which is farther from the fixed sphere not only in place but also in substance and nearer the process of becoming, performs the motion of the fixed [sphere] more slowly (inasmuch as the [Moon's] sphere is smaller)⁴¹ and the contrary revolution faster.

³⁷ 473.4–6 τὴν οἰκείαν κίνησιν τὴν κατ' οἰκείαν ὁρμὴν γινομένην ἀνεμπόδιστον ἔχουσι καὶ κατὰ φύσιν προΐουσιν: or perhaps 'have unimpeded their proper motion, that is, their motion which is according to their proper impulse and which proceeds according to nature': cf. Moerbeke's 'et proprium motum qui secundum proprium impetum fit, non impeditum habent et secundum naturam procedentem' [Bossier n.d.b, 457.3–5].

³⁸ 473.9 οἰκείαν ἔχειν καὶ αὐτάς τὴν ἀπ' ἀνατολῆς κίνησιν: «οἰκείαν» is predicative. It is clear in what follows that the motion to the east is also a *proper* motion, that is, a motion that belongs to each sphere because of its nature [but see Mueller 2005, 13].

³⁹ 473.9–12: Simplicius is focusing on the planetary spheres and their diurnal rotation [cf. Comment 10.09, pp. 208–209].

⁴⁰ 473.15. On the text, see Comment 10.11, pp. 209–210.

⁴¹ 473.18 ὥς βραχυτέρα: this parenthetical remark is inept. Granted, from the fact that the Moon is farthest from the fixed stars, it does follow that its sphere will be smaller and, thus, that its diurnal motion (linear speed) is least. Yet, at issue here is the fact that this westward motion must be natural to the Moon and not forced. In context, then, this remark subverts the effort to locate the Moon's two motions in its very substance; and so it would seem to be a marginal gloss that has crept into the text at an early stage. See Comment 10.11, pp. 209–210.

- [20] It is as if you should conceive in the sublunary [region] some structure of a substance changing from air to water. Certainly, in this structure the substance that has come out a little way from the air has the motion akin to the air (I mean, motion upwards) faster than substances that have come out more [from the air]; whereas it has the motion downwards⁴² slower. And in succession [the substances that come out from the air] have their speed and slowness in proportion to their kinship with the air, with force
- [25] being nowhere evident but their very nature having each. But, while this sort of substantial mixture exists here [in the sublunary region] in fact by change (that is, by opposition), it exists there [in the superlunary region] by procession and subordination, (that is, by alteration of form without opposition).⁴³ Indeed, it has been proven that the [motion] from the east and the [motion] from the west are not opposite motions,⁴⁴ which is in fact why the same [planet] can perform both these motions at the same time
- [474.1] equally according to some single nature that exists by procession (if in fact this argument states any truth in [these] most difficult [matters]). Certainly, in this way the proportion of size in relation to speed⁴⁵ from the upper [spheres] to the lower [spheres] will be preserved as in a single whole, and
- [5] in turn the motion of the wandering [stars] *qua* wandering (which is itself in fact a proper [motion])⁴⁶ will no longer have the proportion of its speed in accordance with the size [of the planetary spheres] but in accordance with its making evident more or less the peculiar character of the wandering [star].⁴⁷

⁴² 473.22–23: the motion characteristic of water.

⁴³ 473.25–28: the hypothesis is here formulated in terms used by the later Platonists. As for the Stoics, Cleomedes [*Cael.* 1.1.115–119 with Bowen and Todd 2004, *ad* 2.3.81–91] holds that the four elements are arranged broadly in layers of decreasing density as one moves upward [see Todd 2001]; and he locates the Moon at the conjunction of aether (construed as a form of fire) and air, noting that its body is made of both. He does not, however, spell out what this might mean for the behavior of the planets—for example, whether the gradation of the density of the aether bears on their sidereal periods. The only consequence which he mentions is that the Moon appears rather murky.

473.26–27 κατὰ πρόοδον καὶ ὑφ'εσιν καὶ εἶδους ἐξαλλαγὴν χωρὶς ἐναντιώσεως: cf. Grosseteste's 'secundum processum et remissionem' [Bossier n.d.a, 144.18] and Moerbeke's 'secundum previetatem et subsequentiam' [Bossier n.d.b, 460.4]. See Comment 10.12, pp. 210–211.

⁴⁴ 473.27–28: cf. *De caelo* 1.4 for Aristotle's argument that no circular motion has an opposite.

⁴⁵ 474.2–3 ἢ τε τοῦ μεγέθους πρὸς τὸ τάχος ἀναλογία. This is not the happiest of formulations: see 97n4.

⁴⁶ 474.4 ὡς πλανωμένων: *scil.* their simple sidereal (or longitudinal) motion eastward; there is no regard here for the planetary stations and retrogradations.

⁴⁷ 474.6 τοῦ πλανωμένου τὴν ιδιότητα: each planet has its own peculiar character.

Alexander⁴⁸ is in fact convinced that, while larger spheres are faster in accordance with their nature, the upper [spheres] move more slowly because they are hindered by the fixed [sphere], on the basis of the fact that, as he says, the spheres of Mars⁴⁹ and Mercury which are higher (so he claims) and, for this reason, larger too than the sphere of Venus,⁵⁰ return in position at the same speed as one another and as the sphere of Venus. For, since the smaller [spheres] are no longer hindered to the same degree by the outermost revolution because of their distance, they move at the same speed as [spheres] larger than they are. [10]

But the claim that the sphere of Mercury is above the [sphere] of Venus is either a scribal error which has Mercury instead of the Sun or it is stated according to the opinion of the ancients, an opinion according to which in fact Plato constructs the [celestial] spheres in his *Republic*⁵¹ when he says that sixth from above is the [whorl] of Venus⁵² which is second in whiteness after Jupiter⁵³ and seventh is the Sun and eighth, the Moon—so that Mercury is placed above Venus. But observations in which the star of Mercury is reported running beneath the [star] of Venus make clear in fact that Mercury is found *below* Venus. This fact is proven as well from the account of the distance of their apogees and perigees, since the greatest distance of Venus is proven somehow to be the same as the distance of the Sun⁵⁴ (so that Venus is close to the Sun), and the greatest [distance] of Mercury is [proven] somehow [to be] near the least [distance] of Venus, and the greatest [distance] of the Moon [to be] near the least [distance] of Mercury. Certainly, these facts are proven in Ptolemy's *Syntaxis*, if the account of the eccentricity of the planets is transformed into an account of their [eccentricity] from the center of the Earth.⁵⁵ But, as has been [15] [20] [25]

⁴⁸ 474.7–32: see fr. 155b in Rescigno 2004–2008, 2.277–284.

⁴⁹ 474.9 τοῦ Ἄρεος. There is an error here: the sidereal period of Mars is not the same as that of Venus and Mercury, as Simplicius well knows [cf. 495.23–29]. Perhaps, we should read 'of the Sun' («τοῦ Ἡλίου») rather than 'of Mars'.

⁵⁰ 474.10 τῆς Ἀφροδισιακῆς.

⁵¹ 474.16: cf. *Resp.* 616e8–617a4.

⁵² 474.17 τὸν τῆς Ἀφροδίτης *scil.* σφόνδυλον.

⁵³ 474.17: Venus is also the second *brightest* object in the night sky, the first being the Moon.

⁵⁴ 474.23: note that, whereas Ptolemy assigns greatest and least distances to the Sun in his *Hypoth. plan.* [cf. Goldstein 1967, 7 col. 1; Morelon 1993, 64–66], at *Alm.* 5.15 he indicates only that it has one distance, 1210 Earth radii. That is, he does not assert that this distance of 1210 Earth radii is a mean distance. So it would seem that Simplicius is indeed drawing on the *Almagest* here, as he says. But see Comment 10.13, pp. 211–213.

⁵⁵ 474.26–28: see Comment 10.13, pp. 211–213.

474.28: *scil.* ἐκκεντρότης. Mueller [2005, 15 and n16] suggests 'distance' (presumably

said,⁵⁶ since this is either a scribal error or a claim made according to a more ancient construction of the [celestial] spheres, it does not need much argument.

Alexander also states another cause of the fact that the [planets] closer to the fixed [sphere] return in position more slowly, namely, that the upper spheres are larger.⁵⁷ Indeed, it is clear that containing [spheres] are larger than contained [spheres]. But, unless the ratios of the distance [from the Earth] to there, that is, [unless the ratios] of the sizes [of the spheres] are known, it is not possible to say that their speeds are proportional to their sizes. For, inasmuch as the sphere of Saturn returns in position in 30 years, that is, in 360 months, let us suppose rather roughly that the Moon [returns in position] in one month:⁵⁸ if in fact the size of the Saturnian sphere were greater than 360 times the [size] of the lunar sphere, it would be possible to declare that the sphere of Saturn moves faster than the lunar [sphere], since what moves a greater distance in an equal time must move faster, especially in case of [bodies] that move smoothly.⁵⁹

Not only Aristotle but also Plato thinks that what moves on smaller circles moves faster than what moves on larger circles.⁶⁰ At any rate, he says in his *Timaeus*:⁶¹

understanding «ἀποστάσεως») [cf. Rescigno 2004–2008, 2.281–282]. Simplicius here calls the distance of the center of each planet's circle from the center of the Earth an eccentricity, and so indicates an alternative usage: see Figure 10.01, p. 181. For the eccentricity of two circles as the distance between their centers, see, e.g., Geminus, *Intro. ast.* 1.31–41; Cleomedes, *Cael.* 1.4.49–71, 2.5.139–141; Theon, *De util. math.* 3.49 [Hiller 1878, 201.7–13]. For the meaning of 'eccentricity' in the *Almagest*, see Comment 10.13, pp. 211–213.

⁵⁶ 474.29–30: cf. 474.14–16.

⁵⁷ 474.30–32. Given this and what follows, Alexander's point is that the linear speeds, i.e., the linear measures of the arc which each planet travels in a given time, are the same. For, since $\Pi = 2\pi/\omega$ (where Π is the planet's period and ω is its angular speed) and $\omega = \vartheta/t$ (where ϑ is the angular distance traveled in time t), then $\Pi_1:\Pi_2 :: \omega_2:\omega_1$. So, if $\Pi_1:\Pi_2 :: r_1:r_2$, then $r_1\omega_1 = r_2\omega_2$ and $r_1\vartheta_1 = r_2\vartheta_2$, which means that the arcs traveled in time t and, hence, the linear speeds are the same.

⁵⁸ 475.2–4: the mean sidereal period of the Moon is 27.321661 days. See Comment 10.14, pp. 213–214.

⁵⁹ 475.4–8. By hypothesis, the ratio of the periods (Π) of Saturn (S) and the Moon (M) is 360:1 and so $r_S:r_M :: 360:1$, where r is the radius of a planetary sphere. On this assumption, the arc that Saturn describes in one month is $1/360$ of its total path. Moreover, this arc must be the same length as that arc which the Moon travels in the same month since both planets move at the same (linear) speed. If, however, $\Pi_S:\Pi_M :: 360:1$ while $r_S:r_M > 360:1$, though the angular distance ϑ_S that Saturn travels in a month remains the same, the linear distance traveled ($r_S\vartheta$) will increase and so become greater than the arc traveled by the Moon. Thus, Saturn will move faster or have a greater (linear) speed than the Moon, though their periods remain the same.

⁶⁰ 475.9–10: this is not a general thesis about circular motion but a claim about planetary periods.

⁶¹ 475.11: cf. *Tim.* 38e6–39a3.

[The beings needed to produce time together] are sent around along the oblique motion of the Different, which goes round through the motion of the Same and is dominated [by it]⁶²—one group of them moving on a greater [circle], the other on a smaller [circle]; those on a smaller [circle] faster, those on a larger [circle] more slowly.⁶³

And in the *Republic*,⁶⁴ when he speaks of the ordering of the [planets] and puts the fixed [sphere] first, the Moon eighth and the others in between, he adds: [15]

the eighth [goes] the fastest of these; the seventh, sixth, and fifth are together with one another, second;⁶⁵ the fourth goes third in motion;⁶⁶ while the third is fourth and the second, fifth.

But Plato *could* be saying that the lower [planets] move faster while focusing on the time interval of their return in position alone—because they do return in position in a shorter [time interval]—but not in fact on the ratio of their size. For, if, as has been said,⁶⁷ the ratio of their size exceeds the ratio of their time interval of motion, it is possible for what returns in position in a shorter time interval to be slower.⁶⁸ [20]

Yet Aristotle seems to find the solution of the problem on the assumption [25] that the motion itself of what is nearer the Earth is faster.⁶⁹ The reason is that, if being dominated and resisted by the fixed [sphere] hinders motion itself and makes it slower, it is clear that the motion of [a planet] nearer the Earth is faster intrinsically and not because of its [faster] return in position. [That

⁶² 475.11–12: διὰ τῆς τοῦ αὐτοῦ φορᾶς ἰόντα τε καὶ κρατουμένην. On the text, see Comment 10.15, pp. 214–215.

⁶³ 475.12 [*Tim.* 39a2] τὸ μὲν ... τὸ δὲ: the definite articles are generic, which facilitates the transition to the plurals in 475.13, «θᾶπτον μὲν τὰ ... τὰ δέ», [*Tim.* 39a2–3]. As Taylor [1928, 203–204 *ad Tim.* 39a2] observes, the construction here is complicated and artificial.

475.14 περιίεται: note that the received text has «περιήειν» ('they kept revolving') [cf. Burnet 1900–1905, vol. 4 *ad Tim.* 39a2].

⁶⁴ 475.14: cf. *Resp.* 617a7–b3.

⁶⁵ 475.16 δευτέρων: Karsten's edition (Heiberg's c) has «δευτέρους» as is found in the Platonic mss.

⁶⁶ 475.17–18: Plato, *Resp.* 617b1–2 has «τρίτον δὲ φορᾶ ἰέναι, ὡς σφίσι φαίνεται, ἐπανακυκλούμενον τὸν τέταρτον» ('Third in motion, as it appears to them, goes the fourth in circling round back [to itself]'). Cf. Bowen 2001, 814–816.

⁶⁷ 475.21: cf. 475.2–8.

⁶⁸ 475.22 δύναντον (omitted in Mueller 2005, 16): the ratio of the radii of two spheres is the same as the ratio of their circumferences; and, if this ratio is greater than the ratio of the period of the greater sphere to that of the smaller sphere, then it follows that the linear speed of the greater sphere is greater than that of the smaller sphere [see 106n59].

⁶⁹ Cf. 471.14–28.

- is, it is clear] unless one should really say that the predominance of the fixed [sphere] does not make the larger revolution (which is, as a matter of fact, faster and can, in so far as it is within its power, return in position together [30] with the smaller [revolution]) appear *that* much faster [than the smaller [476.1] revolution], and that Aristotle would be the one who gives the explanation for this—not of the fact that the [spheres] close to the fixed [sphere] are slower without qualification but of the fact that they *appear* slower than they are [by nature]. For, though the [larger spheres] are going, so far as it is within their power, to return together with the smaller spheres—if it should happen—[these larger spheres] fall short by the amount [that they do] of returning in position together [with the smaller ones] because of the [5] predominance of the fixed [sphere].⁷⁰ Certainly, in this way too the argument that larger [bodies] perform their natural motion faster and by the amount that they are larger remains unshaken. In fact, it is not at all illogical that a particular form have a capacity⁷¹ such that, while it is a specific thing because of itself, it becomes such and such because of the predominance of what is [10] stronger, just as it has limited capacity because of itself but exists and moves without limit because of the unmoved cause.

- Those who say by way of assumption that all the spheres perform the same motion from the east so that day by day the Saturnian sphere returns within a short distance of its position with the fixed [sphere], and the [sphere] of Jupiter within a greater distance and so forth in this way,⁷² escape many other problems, since the motion will in fact have the speeds [15] proportional to the sizes and since things made of the same substance will make the same motion. But this sort of hypothesis has been proven

⁷⁰ 475.28–476.3 Simplicius suggests that each planet has an intrinsic motion to the east, that the larger planetary spheres have by nature a greater linear speed than the smaller ones and almost (note «ὅσον ἐφ' ἐαυτῇ») the same angular speed, and that these larger spheres *appear* slower in their eastward motion than they really are because each night the planets nearer the fixed stars fall short of the fixed stars by less than do the planets farther away.

476.1–3: see Euclid, *Opt. dem.* 54 for argument that, of bodies moving at the same linear speed, the one farther from the observer will appear to move more slowly [cf. Heiberg 1895, 240.14–22].

⁷¹ 476.7 ἐπιτηδεϊότητος (capacity): for discussion of this non-Aristotelian piece of jargon as it used by commentators such as Alexander and Simplicius, see Todd 1972.

⁷² 476.11–14: Simplicius' ruminations in 475.28–476.10 have brought him to consider those theorists in antiquity who might seem to solve the problem that he has been discussing by supposing that the planets actually have only one real motion, the one from east to west. For it follows from this that the planetary motion eastward is an apparent motion, not a real or independent motion. Cf. Theon, *De util. math.* 3.18 [Hiller 1878, 147.14–19].

impossible.⁷³ The reason is that the revolution of any wandering [star]⁷⁴ must be along a circle and this [circle] must always be the same if its motion has been ordained so that it is in fact knowable.⁷⁵ So, will they state that this circle on which they say that each of the wandering [stars] makes its motion from east to west is one of the parallel [circles] or a [circle] oblique to them?⁷⁶ Certainly, if it were [one] of the parallel [circles], [the planetary circles] would not have to come farther south or farther north, nor would they have to rise and set at different positions on the horizon.⁷⁷ But if [they say] an oblique [circle], each of the wandering [stars] would have to appear during each day farther south or farther north because they all go round the oblique circle, as they say, in accordance with each revolution of the universe except for the degrees which they appear leaving behind.⁷⁸ Both these [alternatives] are contrary to the clear [facts].

It is worth knowing that on *every* hypothesis the problem raised about [planetary] stars that keep pace [with one another]⁷⁹—how the containing

⁷³ 476.16–17: cf., e.g., Geminus, *Intro. ast.* 12.14–27 which discusses this account of planetary motion and dismisses it.

It is not clear just who these thinkers were, though speculation both ancient and modern is plentiful [see Aujac 1975, 146] and largely worthless. The most one should say is that this is a possibility entertained by Epicurus (–340 to –269) [see Comment 12.07, pp. 241–244]. But, as for who actually held this account of planetary motion, if it ever was more than a view put forward by Epicurus as merely one among a number of possibilities and kept alive in the philosophical schools, it is most likely that it belongs to the period before the first century BC: for Geminus, this account was a relic from a time when the motions of the planets were not observed carefully against the background of the fixed stars, that is, when there was no awareness of the planetary stations and retrogradations.

⁷⁴ 476.17 τοῦ πλανωμένου: the article is generic, as «αὐτῶν» at 476.18 shows.

⁷⁵ 476.18 εἴπερ τεταγμένη ἔσται αὐτῶν ἡ κίνησις: «εἴπερ» often indicates a condition that the speaker views as in agreement with the facts and so may here be rendered by ‘since’ as well [see Smyth 1971, § 2246].

⁷⁶ 476.20–21: the question is whether each planet makes its westward motion on a circle that is parallel to a great circle on the celestial sphere or on a great circle that is oblique to these parallel circles. The alternatives are not as clear as one should like; but given the criticism that follows, it would seem that Simplicius is asking whether the planets move westward along circles parallel to the celestial equator or whether they move westward along the zodiacal circle.

⁷⁷ 476.21–23: thus, the planets would behave like fixed stars in that they would be unchanging in their relation to the celestial pole and would rise and set at the same point on the horizon. Cf. Geminus, *Intro. ast.* 12.19–21.

⁷⁸ 476.23–27: in effect, the planets would all be like the Sun (though perhaps on different circles), that is, there would be no planetary stations and retrogradations. Cf. Geminus, *Intro. ast.* 12.22–24.

⁷⁹ 476.28 περὶ τῶν ἰσοδρομῶν ἀστέρων. Mercury, Venus, and the Sun are said to keep pace with one another because they were held to have the same sidereal period: cf. 474.9–12 with Comment 12.18, pp. 268–269. Plato [*Tim.* 38d2–4] describes the circuits of Mercury and Venus

- [30] and the contained spheres (or to say the same thing, how the larger and smaller [spheres]) return in position in an equal time interval—still remains a problem. For, whether one says by way of assumption that both the fixed [sphere] and the wandering [spheres] move in the same direction⁸⁰ or that the spheres which come close to the fixed [sphere] move more slowly because they are dominated by it, in neither way is the proportion of the sizes to the speeds preserved in the case of the [spheres] that keep pace [with one another], either when [the spheres] closer to the fixed [sphere] move faster in themselves or when the smaller [spheres] move faster.
- [477.1]

as keeping pace with the Sun in speed (τάχει); and he plainly means only that they have the same period as the Sun, since he adds [*Tim.* 38d4–6] that Mercury and Venus overtake and are overtaken by the Sun [see Bowen 2001, 815–816].

⁸⁰ 476.31 ἀπὸ τῶν αὐτῶν: literally, ‘from the same [parts]’.

(One may suppose with especially good reason that) the shape of each of the heavenly bodies (is spherical. For, since it has been proven that they do not by nature move of their own accord,¹ and since nature does nothing without reason or in vain, it is clear that [nature] has in fact given to these objects incapable of motion a shape of the sort that is least capable of motion. But the sphere is least capable of motion because it has no organ for motion. Consequently,) it is clear that [the heavenly bodies] must be spherical in bulk.

He has in fact already said that the [fixed and wandering] stars are spherical because they are made of the same substance as the heavenly body,² and he has proven through their being spherical that they are least capable of performing locomotion.³ But he was taking their being spherical more as a hypothesis, which is why he has also said the following: ‘Further, since⁴ the heavenly bodies are spherical, just as the others say and it is agreed by us’.⁵ And using the connective particle ‘since’ and not simply a hypothetical,⁶ he reasonably introduced the rather obvious justification [for this] through the phrase, ‘*since*⁷ for our part we generate [them] from that

¹ 291b13 (δὲ αὐτῶν): see *De caelo* 2.8 for Aristotle’s argument that no star (fixed or wandering) moves itself, rather, that each is moved by the heavens as a whole or, more exactly, by a circle (*scil.* sphere) which carries it around. Granted, the argument is ostensibly made in reference to the daily rotation westward of the heavens alone; but it is easily extended to account for planetary motion eastwards and was so understood. At no point, however, does Aristotle explicitly reconcile the claims that such aetherial bodies move by nature in a circle about the center of the cosmos with the claim that this motion is not of their own accord (δὲ αὐτῶν) or intrinsic (καθ’ αὐτό) [cf. 290a9–11].

² 477.6 τῷ οὐρανίῳ σώματι: *scil.* aether, which is shown to be spherical in *De caelo* 2.4.

³ 477.6–7 ἀκίνητα ... τὴν μεταβατικὴν κίνησιν.

⁴ 477.8 ἐπεὶ: Allan [1955] prints «ἐπειδὴ» at *De caelo* 290a7 but the better reading is «ἐπεὶ» [see Moraux 1965, 74].

⁵ 477.8–9: see *De caelo* 290a7–9.

⁶ 477.9 ὑποθετικῶς ἀπλῶς: *scil.* «εἰ» (‘if’). Mueller [2005, 17] misses Simplicius’ lexical point.

⁷ 477.11 εἴπερ: cf. 109n75. The received text at 290a7–9 is

καθάπερ οἱ τ’ ἄλλοι φασὶ καὶ ἡμῖν ὁμολογούμενον εἰπεῖν, ἐξ ἑκείνου γε τοῦ σώματος γεννῶσιν
.... [Moraux 1965, 74]

In breaking this text up, Simplicius omits «εἰπεῖν» but still, I presume, takes «γεννῶσιν» as a dative plural participle in agreement with «ἡμῖν». Mueller [2005, 17: cf. 2004a, 109 and n438]

body'.⁸ Thus, while there he mentions that the heavenly bodies are spherical on account of their motion, now he proves [this claim] directly by using two arguments of which the second is double.

- [15] First is the [argument] from their not performing motion on their own accord. (By [motion] on their own accord, he means a locomotion from place to place: walking is of this sort.) Now, taking once more as an axiom that nature does nothing without reason, and holding as proved in advance that the heavenly bodies are immovable with regard to locomotion on their own accord, he reasons in effect as follows:

- [20] The heavenly bodies are incapable of locomotion on their own accord. Bodies of this sort have no organ for this sort of motion because nature does nothing without reason. But bodies that have no organ for [loco]motion are spherical because they have no protuberance. 'Consequently, it is clear that' the heavenly bodies 'must be spherical in bulk', that is, in body.⁹

- [25] But, if he proved earlier that [heavenly bodies] do not move by changing place because they are spherical (by considering the motion that is proper to spherical [bodies] on the basis of a division),¹⁰ and if he now proves that they are spherical from their not moving [from place to place], how is the proof not circular?¹¹

- [478.1] Now, they say¹² in reply that he neither proved their not moving [by changing place] through their spherical [shape] alone nor their spherical [shape] through their not moving [from place to place] alone, but that both the former [conclusion] and the latter are proven through *many* arguments. And for this reason, says Alexander, the proof is not circular.

takes it as a finite verb (third person plural present indicative active): note Grosseteste's 'siquidem ex illo corpore genus communicant' [Bossier n.d.a, 149.17–18] and Moerbeke's 'si vere ex illo corpore generant' [Bossier n.d.b, 472.2–3]. But «ἐξ ἐκείνου γε τοῦ σώματος» is a reference to the οὐράνιον σώμα [477.6], where this σώμα is aether [cf., e.g., *De caelo* 289a13–19]; and, though Simplicius may presume to read the doctrine of aether back into Plato's writings, we at least should be very clear that it is Aristotle who is the originator of the thesis that the heavenly bodies are made of aether.

⁸ 477.11–12: see *De caelo* 290a8–9.

⁹ 477.22–23: cf. *De caelo* 291b16–17.

477.24–478.8 = fr. 156a in Rescigno 2004–2008, 2.284–285.

¹⁰ 477.25 ἐκ διαιρέσεως (on the basis of a division). At *De caelo* 290a7–12, Aristotle proposes that a spherical body can move on its own accord in only two ways—by rolling (κύλισις) or by rotating (δίνησις).

¹¹ 477.26 διάλληλος: a technical term. The concern, according to Themistius [Landauer 1902, 118.32–37], is whether the argument is a demonstration *ignoti per ignotum*, that is, a type of *demonstratio circularis*.

¹² 477.27 λέγουσιν: it is unclear who 'they' are, though they obviously include Alexander and Themistius [see Landauer 1902, 118.37–119.2 = fr. 156b in Rescigno 2004–2008, 2.285–286].

But how does the fact that the same conclusion is drawn from other arguments as well make *this* demonstration not circular? Certainly, while the fact that [this conclusion] is demonstrated not only through these circular [arguments] but also through other [arguments] may be a sign that, and a reason why, [the conclusion] is not overturned, how can this be a sign that, or reason why, these proofs are not circular? [5]

Perhaps, then, Aristotle took spherical [shape] and not having an organ for locomotion (which necessarily implies not moving by changing place) as convertible and reasonably demonstrated the one from the other, just as someone might infer having milk from having given birth and having given birth from having milk or that it is man from being a mortal rational animal and the definition from man.¹³ For proofs that are circular in this way are not to be cast aside. [10]

One should understand from these [remarks] as well what kind of motion Aristotle denies the heavenly bodies, namely, the motion not proper to spherical shapes, that is, locomotion by means of organs. For, with regard to this sort of motion, he says that the spherical shape is least capable of motion and adds the reason—‘*because [it] has no organ for motion*’¹⁴—inasmuch as he said that motion within itself¹⁵ is most proper to spherical [bodies], not only to the heavens but also to the heavenly bodies, when he wrote the following: [20]

This is in fact why the heavens as a whole and each of the heavenly bodies seem with good reason to be spherical. For the sphere is the most useful of shapes for motion within itself,¹⁶ since it can move very fast in this way and above all occupy the same place. But it is least useful for motion forwards, since it is least like [bodies] that move¹⁷ of their own accord because it has nothing hanging loose or projecting as a rectilinear [shape does].¹⁸ [25]

In fact, what is said here¹⁹ also agrees with these words in that Aristotle says that the heavenly bodies make this apparent change in position not

¹³ 478.13 ὁρισμόν: man is defined as a mortal rational animal. This definition, which does not actually appear in Aristotle's writings, is a stock example in the works of Alexander of Aphrodisias for instance. Cf. Todd 1976; Rescigno 2004–2008, 2.286.

¹⁴ 478.18–19: see *De caelo* 291b16.

¹⁵ 478.19 τὴν ἐν ἑαυτῷ κίνησιν: *scil.* rotation.

¹⁶ 478.22 ἐν ἑαυτῷ. Moraux [1965, 76] prints «ἐν ἑαυτῷ» at *De caelo* 290b2: cf. Moerbeke's ‘in se ipso’ [Bossier n.d.b, 476.6]. Others [cf. Allan 1955, ad loc.] have «ἐν τῷ αὐτῷ» (‘in the same [place]’).

¹⁷ 478.25 κινουμένοις. Moraux [1965, 76] prints «κίνητοις» (‘capable of motion’) at *De caelo* 290b5–6.

¹⁸ 478.21–26: see *De caelo* 290a35–b7.

¹⁹ 478.27: *scil.* in *De caelo* 2.11.

- [30] on their own accord, and clearly presents their [motion] within themselves as a proper [motion] of spherical shape. This is why he also says both things about spherical shape, namely, both that it is least capable of performing locomotion on its own accord and that the sphere is the most useful of shapes for motion within itself.

291B17–23

Further, one and all [the heavenly bodies] are alike,²⁰ (and the Moon shows through visual [evidence] that it is spherical: certainly, [if the Moon were not spherical,] it would not as it waxes and wanes become for the most part crescent-shaped or gibbous²¹ and halved²² only once. And, again, [it is shown] through astronomical [considerations] that the eclipses of the Sun would not be crescent-shaped. Consequently, since one [heavenly body] is like this, it is clear) that the others too must be spherical.

- [479.3] As for the second argument, this one is probative of the spherical [shape] of the heavenly bodies in that it applies the axiom which says that any
 [5] one of the heavenly bodies and all are alike in shape since they are all in fact [made] of the same substance which is simple.²³ So, if the Moon is proven spherical from its observed illuminations, it is clear ‘that the others too must be spherical’.²⁴ Certainly, if [the Moon] were not spherical but, perchance, drum-shaped or lentil-shaped,²⁵ its illuminations would not, he
 [10] says, become such that as it waxes and wanes it appears ‘for the most part crescent-shaped or gibbous and dichotomos²⁶ only once’.²⁷

²⁰ 479.1: Simplicius’ lemma opens with «Ἦτι δέ, εἰ ὁμοίως μὲν ἅπαντα καὶ ἓν», which entails a slightly different sense:

Further, [the Earth is spherical] if one and all are like, (and the Moon shows through visual [evidence] that it is spherical. Certainly, [if the Moon were not spherical]

²¹ *De caelo* 291b20 ἀμφίκυρτος (gibbous): literally, ‘bulging or curved outwards on both sides’.

²² *De caelo* 291b21 διχότομος.

²³ 479.6: *scil. aether*. Cf. *De caelo* 1.2 where it is argued that the heavenly bodies are made of aether.

²⁴ 479.7: see *De caelo* 291b23.

²⁵ 479.8 φακοειδής: the lentil resembles a circular lens with two convex sides.

²⁶ 479.11 διχότομον. Usually, this means ‘halved’, as I have already rendered it above. But, since it is difficult to capture in English the linguistic point Simplicius is making here, I will simply transliterate the Greek in the next few lines and use footnotes to clarify what is at issue. Grosseteste’s solution to the problem of conveying Simplicius’ point to readers unfamiliar with the Greek names of the lunar phases was to interject a brief note explaining the meaning of the key terms: cf. Bossier n.d.a, 153.25–154.29.

²⁷ 479.10: see *De caelo* 291b20–21.

However, if he were calling the Full Moon *dichotomos*, as Aratus called it *dichomēnos*²⁸ because of its dividing the month into two,²⁹ the rest [of what he says]³⁰ would be in accord with the fact that [the Moon] often appears crescent-shaped,³¹ since [the Moon is crescent-shaped] both when it waxes and when it wanes (and likewise gibbous). But, inasmuch as a little later he applies the term *dichotomos* as we in fact ordinarily mean it when he says, [15]

*That is to say, we have seen the Moon when it was dichotomos as it came under the star of Mars (which was in fact hidden³² at [the Moon's] dark side and came out at the bright,³³ radiant side).*³⁴

[these lines]³⁵ set forth the meaning of '*dichotomos only once*'³⁶ nicely. For [the Moon] both as it waxes and as it wanes becomes both crescent-shaped and gibbous for a rather extended interval of time, since the more and the less are in these shapes.³⁷ [The Moon] will also³⁸ become *dichotomos* both as it waxes and as it wanes, but not for a specific time interval—the more and the less are not in this shape.³⁹ Instead, the time interval for [its shape when halved] is momentary, the very thing which '*only once*' makes clear.⁴⁰ [20]

²⁸ 479.11 διχόμημον (bisecting the month). Cf. Aratus, *Phaen.* 78, 737. Kidd [1997, 427–428] remarks that Aratus' «διχόμενα δὲ παντὶ προσώπῳ» at *Phaen.* 737 involves a slightly confusing word-play between the half-moon, which is the first-quarter, and the half-month, which is the full-moon. Simplicius detects the same ambiguity in Aristotle's «διχότομος».

²⁹ 479.11 the Full Moon is called διχότομος because it divides the month into two halves. Thus, «διχότομος» is given an active sense and 'only once' is taken to mean 'only once during the month'.

³⁰ 479.12: viz. concerning its being gibbous and διχότομος.

³¹ 479.12: see Comment 11.01, pp. 217–218.

³² 479.16 ἀποκρυβέντα: Moraux [1965, 81] prints «ἀποκρυφθέντα» at *De caelo* 292a5.

³³ 479.17 φανερόν: Moraux [1965, 81] prints «φανόν» at *De caelo* 292a6.

³⁴ 479.15–17: see *De caelo* 292a3–6. On Aristotle's report of this occultation, see 481.8–15 and Comment 12.02, pp. 224–225.

³⁵ 479.18 ἐξηγούνται: the subject is unspecified. Mueller [2005, 19 and n47] takes it to be a contextually undefined 'they' which he improbably understands to mean Alexander: see 112n12.

³⁶ 479.18 ἅπαξ διχότομον: see *De caelo* 291b20–21 for «ἅπαξ διχότομος».

³⁷ 479.22: that is, being crescent-shaped or gibbous admits of variations in quantity.

³⁸ 479.20 καὶ γίνηται (= καὶ ἂν γίνηται): the subjunctive is anticipatory. Mueller [2005, 19] misconstrues the syntax by understanding «καὶ εἰ ἂν γίνηται» ('even if it is also') and has Simplicius 'entertaining' the possibility of dichotomy rather than observing that the waxing and waning of the Moon will produce dichotomy.

³⁹ 479.21–22: thus, being halved does not admit of variations in quantity.

⁴⁰ 479.23: the Moon is here called διχότομος when it is divided into halves, that is, when it is at the quarter (either the first or the third). Thus, «διχότομος» is given its more usual passive sense of 'halved' or 'bisected' and 'only once' is construed as 'only for a moment'. It is perhaps misleading to say, as Leo Elders does [1966, 230], that the Moon is διχότομος in this sense for a 'short while': Simplicius is skirting the claim that the Moon is halved for an instant.

These shapes of the [lunar] illuminations are features characteristic of a spherical [body] because, given that a hemisphere [of the Moon] is always illuminated,⁴¹ when the Moon comes beneath the Sun and is at the same degree [of longitude], the part [of the Moon] toward the Sun is illuminated and the part toward us is dark. But, when [the Moon] stands apart from the Sun, the hemisphere that is always illuminated⁴² leaves behind the same amount of the other part⁴³ as it receives from the [hemisphere] toward us.⁴⁴ That is why [the Moon] appears crescent-shaped until the half; and, when half of the upper [hemisphere] and half of the [hemisphere] facing us are illuminated, that is, when [the Moon] stands apart from the Sun at a quartile distance, it is seen as halved.⁴⁵ From there until diametrical opposition,⁴⁶ [the Moon] appears gibbous; but, when it is diametrically opposed [to the Sun], the entire hemisphere facing us is illuminated and the [hemisphere] looking upward is not. And again, as the [Moon] approaches the Sun, it maintains for us a gibbous, a halved, and a crescent-like [shape], and in conjunction a dark [shape].⁴⁷ The reason is—what I said [above]—the fact that, since the Moon is spherical, a hemisphere of it is always illuminated.

Consequently, if [the Moon] were in truth drum-shaped or lentil-shaped, it would be the same as it currently is in its conjunctions and Full Moons. But, when it stood apart from the Sun at any distance whatsoever in either direction, [the Moon] would no longer be crescent-shaped or halved or gibbous. Rather, the [part] facing us would be illuminated entirely because there is no obstacle to the [Sun's] rays in the case of a drum-shaped [Moon];

⁴¹ 479.24 ἡμισφαίριον ἀεὶ φωτιζόμενον: that one hemisphere is always illuminated is a condition of there being lunar phases, not a cause [but see Mueller 2005, 19].

⁴² 480.1 τὸ φωτιζόμενον ἀεὶ ἡμισφαίριον: not 'what is illuminated is always a hemisphere', as Mueller [2005, 19] has it.

⁴³ 480.1–2: that is, the part that was turned to the Sun and illuminated during conjunction.

⁴⁴ 480.2: in other words, the intersection of the hemisphere that is always illuminated and the hemisphere that is facing us is equal to the complement of these same two hemispheres. See Figure 11.01, p. 182.

⁴⁵ 480.3: the direction from the Earth along a radius of the celestial sphere to the fixed stars is up. Thus, the upper hemisphere is the complement of the hemisphere that is toward us.

480.4 τετραγωνικὴν διάστασιν. The notion of a quartile distance apparently derives from astrology and originally pertains to zodiacal signs that are separated by three zodiacal signs or 90°: cf. Geminus, *Intro. ast.* 2.16–26; Ptolemy, *Tetrabib.* 1.13.

480.4 διχότομος ὁράται (it is seen as halved): that is, as bisected or at the (first) quarter.

⁴⁶ 480.5 μέχρι τῆς διαμέτρου. This term may have an astrological nuance as well: cf. Geminus, *Intro. ast.* 2.2–6; Ptolemy, *Tetrabib.* 1.13.

⁴⁷ 480.8: see Figure 11.01, p. 182. For an even fuller account of the lunar phases along the same lines, see Cleomedes, *Cael.* 2.5 [Bowen and Todd 2004, 145–149].

whereas, in the case of a lentil-shaped [Moon], the shape of the illumination would turn out to be different since there is a little bulge in the middle.⁴⁸ [15]

Next, he introduces another proof also from astronomy, namely, ‘*that the eclipses of the Sun would not be crescent-shaped*’⁴⁹ as they are now seen [to be], unless the Moon which comes beneath it were spherical. Certainly, it has been proven that, when a sphere is obscured by a sphere, the sections [of the sphere obscured] are of this sort.⁵⁰ But never in fact do other rounded [objects], such as drum-shaped and lentil-shaped [bodies], produce sections that are crescent-shaped when they cover [a sphere].⁵¹ Indeed, if it is posited that they move about their own centers, drum-shaped or lentil-shaped [bodies] will no longer produce sections at every position.⁵² [20]

⁴⁸ 480.10–15: see Figures 11.02 and 11.03, pp. 184, 185 with Comment 11.02, pp. 218–219.

⁴⁹ 480.16–17: see *De caelo* 291b21–22.

⁵⁰ 480.17–19: see Comment 11.03, pp. 219–220.

⁵¹ 480.19–21: see Comment 11.04, pp. 220–221.

⁵² 480.21 εἰ: Simplicius maintains that heavenly bodies rotate [see Comment 11.05 p. 221].

480.23–24 τὰς ἀποτομάς. Heiberg, followed by Mueller [2005, 20 and n52], suggests «τοιού-
τας τὰς ἀποτομάς» (‘sections of this kind’). As Figures 11.02 [p. 184], and 11.03 [p. 185] show, both
the drum-shaped and lentil-shaped Moons have full phases, but only the lentil-shaped Moon
has any sections at all (dichotomy and a brief gibbous phase). In either case, if we suppose
Simplicius to understand that the Moon completes one rotation about its axis in the time of
one revolution about the Earth (so that one always sees the ‘Man in the Moon’ [see Comment
11.05, p. 221]), it is plainly true that the Moon would not have sections at every position. So
the text needs no emendation.

IN ARISTOTELIS DE CAELO 2.12

291B24–292A18

Since there are two problems¹ (about which anyone might reasonably be at a loss, we should try to state the apparent [solution], bearing in mind that eagerness amounts more to respect than to rashness² if someone on account of his thirst for philosophy welcomes even small advances in matters about which we have the greatest problems.

Of such [problems] (which are numerous) not least astounding is why³ the [bodies] which are more distant from the first motion do not always perform more motions, but why the ones in between [perform] the most motions. Certainly, it would seem reasonable⁴ that, since the first body performs one motion, the body nearest it perform the least number of motions, for example, two, and the next [body] three, or some other such ordering [of motions]. But, as it is, the opposite is the case, since the Sun and Moon perform fewer motions than some of the wandering stars; and yet [these wandering stars] are farther from the center [of the cosmos] and nearer the first body than they. (This has become clear in some cases even to sight.⁵ That is to say, we have seen the Moon when it was halved⁶ as it came under the star of Mars (which was in fact hidden at [the Moon's] dark side and came out on the bright, radiant side).⁷ And the Egyptians and Babylonians, who have long made observations over a very great number of years and from whom we have many reports about each of the heavenly bodies, say similar things about the other [wandering] stars.)⁸

¹ 480.24: *De caelo* 291b24 Δυσὶν δ' ἀπορίαις οὐσαῖν [Moraux 1965, 80]. This is the reading of the *lemma* found in one family of mss of Simplicius' commentary that Heiberg regards highly. Still, he prefers the «Δυσὶν δ' ἀπορίων οὐσῶν» found in A, the primary ms. [1894, v].

² *De caelo* 291b25: «ἄξιαν» with genitive (lit. 'worth as much as', 'equal in worth to'). Cf. Grosseteste's 'verecundia dignum esse existimantes desiderium magis quam audacia' [Bossier n.d.a, 156.3–4].

³ *De caelo* 291b29 [cf. 292a10–11] διὰ τίνα ποτ' αἰτίαν: lit. 'for whatever reason'.

⁴ *De caelo* 291b31: see 97n5.

⁵ *De caelo* 292a3: *scil.* that the Sun and Moon are nearest the center of the cosmos, the Earth.

⁶ *De caelo* 292a4 διχότομον: see 479.10–23.

⁷ *De caelo* 292a5, 6: «κατὰ» with accusative (on/at something): cf. 481.11. Mueller [2005, 20–21] has 'by' and 'from'. The Moon is halved at what we call the First and Second Quarters; it has come 'beneath' Mars when it is between Mars and the observer.

⁸ *De caelo* 292a7–9 ἀστέρων ... ἄστρων: on the translation of these terms, see Comment 10.02, pp. 201–202.

One might quite rightly raise this as a problem, as well as [the problem] why there is so great a multitude of heavenly bodies in the first motion that their entire ordering seems to be uncountable, whereas each of the other [heavenly bodies] is one by itself and there are not observed two or more fixed in the same motion.

About these [matters], then, it is good to seek even greater understanding, although we have little to start with and are at such a great distance from what takes place concerning them. Nevertheless, the problem now raised should not seem [to us] anything unreasonable⁹ (if we make our study from the following sorts of [starting points].)

- [480.26] He proposes two remaining problems about the heavenly bodies which are really quite intractable.¹⁰ The first of them is like this: ‘Given that the fixed [sphere] performs one motion, why does what is closest to it, namely, the sphere of Saturn, not perform the least number of motions, say, two, and the one after that three [motions] or [motions determined] according
- [30] to some other proportional ordering of numbers, so that the [wandering stars] which are farther [from the sphere of the fixed stars] always per-
- [481.1] form more motions?’ Instead, the opposite occurs. For the Sun and Moon, which are lower than the others—he too in fact hypothesizes that the Sun is proximately above the Moon, just as Plato did as well—‘*perform fewer motions than some of the wandering stars*.’¹¹ (Actually, among the wander-
- [5] ing [stars], the motion of the Sun is the simplest and that of the Moon is simpler than the rest.)¹² And yet the higher [wandering stars], which are farther from the center and nearer the fixed [sphere]—which he calls first

⁹ 480.24 ἀν ἀλογον εἶναι δόξειε: the better mss of *De caelo* have «ἀλογον ἀν δόξειεν εἶναι» [cf. Moraux 1965, 81].

¹⁰ 480.26 ἀπορωτάτας (most intractable): lit. ‘most problematic’ [cf. 482.5]. Yet Aristotle is moved to raise them because they follow readily from what precedes. After all, *De caelo* 2.9, with its critical discussion of the Pythagorean notion of cosmic ἀρμονία, broaches the more general question of the existence of proportionality in the distances and motions of the planetary bodies; and 2.10 addresses this more general question in earnest. The novelty in 2.12 is the allowance that each planet has more than two motions.

¹¹ 481.3: cf. Plato, *Resp.* 616e8–617a1; *Tim.* 38c7–d2.

481.3–4: cf. *De caelo* 291b35–292a1. See Comment 12.01, pp. 223–224.

¹² 481.4–5: if the simplicity in question here concerns varieties of characteristic motion, Simplicius may simply be supposing that the Sun has a simple direct motion in longitude, that the Moon has a simple direct motion in longitude, a motion in latitude, as well as a nodal motion [495.10–13; see Comment 12.16, pp. 265–266], and that the five planets have in addition to a motion in latitude a more complex motion in longitude that is punctuated by stations and retrogradations. Alternatively, he may be indicating the sort of modified Eudoxan homocentric theory that Easterling [1961] describes: see Comment 12.01, pp. 223–224.

body¹³—should have motions that are simpler than [those] of the Sun and the Moon. (He also proves that the Moon is lower than the rest from its reported occultings,¹⁴ of which he says that he personally has seen one, the occulting of Mars: for he states that, when [the Moon] was halved, it came under the [star] of Mars and that [Mars] was hidden at [the Moon's] dark side and came out at its bright side¹⁵—so that [the Moon] was halved as it waxed.¹⁶ But, whereas he personally watched this, the Egyptians and Babylonians have observed the same thing occurring with the other [wandering] stars as well (that is, with those that are higher), so that many of their observations of each of the [wandering] stars have been handed down.¹⁷)

Next, he also introduces the second problem¹⁸—‘*why there is so great a multitude of stars in the fixed [sphere] that it seems to be uncountable, whereas in each of the spheres beneath it there is not observed more than one star present*’. And, then, looking to the danger of his inquiry and reckoning that it is formidable because of the magnitude of the problems, he offers encouragement by saying,¹⁹ ‘*It is good, then, to inquire about these matters and²⁰ to receive or, rather, to seek after, even greater understanding*’.²¹

¹³ 481.6–7: cf. *De caelo* 292a2.

¹⁴ 481.9 ἐκ τῶν ... αὐτῆς ὑποδρομῶν: lit. ‘from its passages under’ [cf. Mueller 2005, 21], but this is unnecessarily ambiguous. Simplicius is thinking of the phenomenon of occultation and not just the coincidence of the Moon and some other planet in longitude. See Comment 10.06, pp. 205–206.

¹⁵ 481.10–12: cf. *De caelo* 292a3–6. See also Aristotle, *Meteor.* 343b30–32 (Aristotle reports Jupiter’s occultation of a star in the constellation Gemini). See Comment 12.02, pp. 224–225.

¹⁶ 481.11: that is, the Moon was at First Quarter.

¹⁷ 481.14–15 ὥς ... παραδεδόσθαι. Simplicius rightly presents the Babylonian observations as an institutional program, one that was in fact remarkably long-lived. The existence of such a program of Egyptian observation is substantially less clear, and so one must wonder what exactly Simplicius has in mind (if anything more than just what Aristotle writes). Mueller [2005, 21] has ‘as has been conveyed by many of their observations concerning each star’, but this strains the syntax.

Cf. Aristotle, *De caelo* 292a7–9 and *Meteor.* 343b28–30 with [Plato], *Epin.* 987a1–6. See Comment 12.03, pp. 225–226.

¹⁸ 481.16: cf. *De caelo* 292a10–14.

481.16–24: see fr. 157b in Rescigno 2004–2008, 2.287–290.

¹⁹ 481.20–21: παραμυθεῖται: this might also mean ‘offers reassurance (or even consolation)’. Cf. Grosseteste’s ‘mitigat’ [Bossier n.d.a, 157.3] and Moerbeke’s ‘consolatur’ [Bossier n.d.b, 487.4].

²⁰ 481.21 Heiberg has «περὶ μὲν δὴ ...», but notes that «μὲν» is omitted in Karsten’s edition: Moraux 1965, 81 *ad* 292a14 reports that «μὲν» is found in some mss of the *De caelo*.

²¹ 481.21–22: cf. *De caelo* 292a14–15. This is a paraphrase, not a proper quotation.

- In fact, Alexander thinks that the thought is rather elliptical at this [point] because what is added to it [in what follows] seems to be more fitting.²² But
 [25] perhaps the thought has not been stated elliptically, since Aristotle was not used to expressing his meaning in an elliptical fashion, even if he was given to abbreviated discourse. Rather, he means that those who are especially intelligent, not just anybody, should investigate matters of this sort and not shrink back, *'even if they have little to start with concerning them and stand apart from what happens concerning them in more than spatial distance'*, as he said elsewhere.²³ Nevertheless, even if this is the case, on the basis
 [30] of the arguments to be stated, the problem raised now should not seem unreasonable.

292A18–B10

But we (conceive) [of the heavenly bodies] as [we do] of mere bodies only,²⁴ (that is, as [we do] of units which have order but are utterly without soul; whereas we should form our understanding on the assumption that they share in action and life, since in this way what follows will not seem at all unreasonable.²⁵

For the good seems to belong without action to what is in the best state; to what is nearest [this], through a single, slight action; and to things farther [from this], through many actions. Likewise, in the case of the body, one [body] is well, though it does not exercise; another [is well] by walking short distances; but for another there is in fact a need of running, wrestling, and exercise in the arena;²⁶ and again for another, however many things it works at, this good will still not belong to it, but something else.²⁷ For succeeding either at many things or often is difficult, just as it is impossible to throw 10,000 'Chian' knucklebones but easier [to throw]

²² 481.22–24: Moerbeke has 'in hoc enim sermonem magis deficere putat Alexander quia quod superfertur huic magis correspondens esse videtur' [Bossier n.d.b, 487.7–9]. See Comment 12.04, pp. 226–227.

²³ 481.28: cf. *De caelo* 292a15–17. See, e.g., *De part. an.* 644b22–645a5, where Aristotle emphasizes our difference in nature from the celestial bodies, and *De caelo* 286a3–7. Cf. Falcon 2008, 85–112.

²⁴ 482.1 μόνον αὐτῶν: Moraux [1965, 81] prints «αὐτῶν μόνον». These readings as well as «μόνων αὐτῶν» and «αὐτῶν μόνων» are found in the mss of both Simplicius' text and the *De caelo*.

²⁵ *De caelo* 292a14–18: this passage has occasioned controversy. See, e.g., Elders 1966, 234–235; Leggatt 1995, 248–249; and Comment 12.05, pp. 227–229.

²⁶ *De caelo* 292a26 χονίσεως: lit. 'a workout in the dust'. Cf. 482.30–483.2.

²⁷ Cf. *De caelo* 292a15–17.

one or two.²⁸ And again, when one must do [A] for the sake of [B] and [B] for the sake of [C] and [C] for the sake of [D], it is easy to succeed in one or two [steps] but more difficult to the degree that it is through more [steps].

This is why we must hold that the action of the heavenly bodies is in fact of the same sort as the [action] of animals and plants. Indeed, down here, the actions of man are greatest in number, since [man] can attain many goods, so that he does many things (for the sake of other things too). (What is as good as possible has no need at all of action, since it is itself its goal; whereas action always depends on two [factors] since there is both that for the sake of which [there is action] and what is for the sake of this.²⁹) But, [the actions] of the other animals are fewer in number; whereas there is perhaps some slight and single [action] of plants, since there is either some one [good] which they can attain just as man also does or there are in fact many [goods] all conducive to the best.³⁰

His remarks up to now have concerned the two problems. From this point, he sets out for the solution of the former and states first the reason why the argument seems quite intractable, namely, that [this is] not due to the object of inquiry but to those making the inquiry. That is to say, we consider the problem unsolvable because we conceive of the heavenly [bodies] as [we conceive] ‘*of mere bodies*’ without souls, that is, as it were, as [we do] of numerical ‘*units*’ which have only position in relation to one another

[482.3]
[5]

²⁸ *De caelo* 292a29 ἀσπεράγλους. In a note prefacing his translation of this lemma, Grosseteste draws on the *Suda* and writes:

I have found it written as follows in an authentic presentation of parts of Greek which are in rare use:

According to customary speech, an *astragalos* is both the vertebra of the neck and a [small stone] for gambling, but a plant [*scil.* milk vetch] is also called thus. Further, what Balthasar, the son of Nabugodonosor [*scil.* Nabuchodonosor], saw on a facing wall while reclining during a dinner as the finger-joint [probably not ‘wrist’] of a human hand writing in Hebrew things which no one could understand is called an *astragalos*. But when he summoned Daniel and asked that this be interpreted for him, Daniel said to him, ‘The finger-joint that you saw belongs to the hand of the living God and it has written that [‘quoniam’ for «ἐτι» (‘that’)]. He has measured and brought your rule to its completion.’ On hearing this, therefore, Balthasar was distressed; and after a short while he was killed by Darius the Mede. [Bossier n.d.a, 157.16–28; cf. Adler 1928–1938, 1.392]

See 126n46.

²⁹ *De caelo* 292b6–7: viz., a goal and a means to this goal [cf. Moraux 1965, 82]. Mueller [2005, 22] mistakenly takes «ἐν δύοσιν» to mean ‘of two kinds’ rather signifying dependency on two items, and misconstrues what follows.

³⁰ See *De gen. an.* 731a24–26, where Aristotle maintains that the only function and action of plants is to produce seed.

and are '*utterly without soul*'.³¹ And, certainly, it would be unsolvable if they
 [10] were so, given that from [such bodies] no starting point for a solution is
 found. But we must think of [the heavenly bodies] as though living things
 possessing a *rational* soul so that they share in both action and an active
 life, since we apply 'doing' both in the case of irrational souls and in the
 case of bodies without souls but predicate 'acting' characteristically³² in
 the case of rational souls. Thus, if we think of them as being so, what
 [15] follows for the motions of the heavenly [bodies] should not seem contrary
 to reason.

Certainly, inasmuch as these [bodies] are active and every action comes
 to be through motion for the sake of the good, it is clear that, in the case
 of what is in the best state,³³ namely, what is either good itself or united
 essentially to the good itself like the Prime Mover—the highly esteemed
 [20] Intellect³⁴ is of this sort—these things³⁵ are and have the good apart from
 action and motion.³⁶ Or, as he himself says, in one [sense, what is in the
 best state] has [the good] and, in another, it shares in [the good] proxi-
 mately.³⁷

[It is also clear] that the good belongs to what is nearest [what is in
 the best state] through a slight, single motion, just as it does to the fixed
 [sphere]; and that [the good belongs] to those that are farther away through
 a greater number [of motions], as it does to the planets. And [it is clear
 too] that some [heavenly bodies] cannot even attain that [good] immedi-
 ately but are content to approach those that do attain [the good], just as the

³¹ 482.6–8: an instructive paraphrase of *De caelo* 292a18–20. Note that Aristotle's «τάξις» ('order') is rendered by 'position (τάξις) in relation to one another'. Mueller takes the conjunction «ὥς» to mean 'as if': but note Simplicius' «ὥς γὰρ περὶ σωμάτων ... οὕτω περὶ τῶν οὐρανίων διανοούμενοι» and see Comment 12.05, pp. 227–229.

482.8: «τὸ πάμπαν», instead of just «πάμπαν» at *De caelo* 292a20 [see Moraux 1965, 81].

³² 482.13 ἰδίως: *scil.* 'exclusively'.

³³ 482.17 τῷ ἄριστῳ ἔχοντι (what is in the best state, what is best): not 'things which possess the best' [Mueller 2005, 23, 24, and n78]: cf. Smyth 1971, § 1438.

³⁴ 482.19 πολυτίμητος: an epithet used in addressing divinities. Simplicius identifies what is in the best state (292a22, 292b5–7) with the Intellect which is treated as a divinity or god: cf. Easterling 1961, 150–152; Leggatt 1995, 250.

³⁵ 482.19 «ταῦτα» (not «τοῦτο») produces a mild asyndeton. Grosseteste [Bossier n.d.a, 159.22] and Moerbeke [Bossier n.d.b, 491.2] have 'haec'.

³⁶ 482.20: the point is not that these things are without action *and* possess the good [so Mueller 2005, 23], but that they both *are* the good and *possess* the good *without* action or motion.

³⁷ 482.20–21: cf. *De caelo* 292b10 ('Thus, the one has and shares in the best ...'). Simplicius attempts to read Aristotle in support of the point just made about what is in the best state: note «ἢ, ὥς αὐτός φησι». Mueller [2005, 23 'Or, as he says, one thing has it and another shares in it directly'] overlooks the connection.

Earth does and is for this reason immobile, or [just as]³⁸ the whole [region] [25]
beneath the Moon too, given that [motion] in a straight line is in fact characteristic of imperfect beings, whereas fire and the upper air have circular motion in common with the heavens.³⁹

Next, he says, using the body and its health as an example, one body (which is analogous to what is immobile)⁴⁰ is well even apart from its having exercised because of its being structured in the best way. ‘Another’ [body] (which he compared to the fixed [sphere]) [is well] ‘by walking short distances.’⁴¹ And for another [body], there is need of a greater number of exercises for being healthy, say, running and wrestling, that is, athletic training [30]
in wrestling (‘a workout in the dust’ is like this because wrestling moves are practised in the dust).⁴² This one is taken as analogous to a wandering [star]. [483.1]
But, to [a body] disposed in an extreme state ([a body] which he has likened to [the region] beneath the Moon), the unmixed benefit of health does not belong however many things it works at, since it cannot share in the divine [5]
Goodness immediately and because of this does not move by itself.⁴³

But, perceiving that the argument is still inadequate—in other words, that he has not stated the reason for the distinction in what wanders, namely, why the Sun and the Moon perform fewer motions while the upper wandering [stars perform] more⁴⁴—he fills in what is missing by saying that [10]
objects more worthy of honor do more things because of their being ‘able to attain many good things’,⁴⁵ and that it is more fitting for them to succeed at

³⁸ 482.24 ἤ: Heiberg prints «ἤ». But Moerbeke has ‘aut’ [Bossier n.d.a, 491.9] and Grosseteste has ‘vel’ [Bossier n.d.ba, 159.28].

³⁹ 482.24–26: Mueller [2005, 23] overlooks the use of «εἰμί» with the genitive to indicate the nature or the characteristics of the substantive in the genitive case [see Smyth 1971, §1304].

Simplicius is addressing Aristotle’s assertion at *De caelo* 292b19–20 that the Earth (ὀλῶς) does not move. Cf. *De caelo* 277b12–24 and 4.4. The assertion [*Meteor.* 344a8–13] that fire and the upper air move in a circle in common with the heavens has proven troublesome given the *De caelo*’s contention that aether is the only simple body that moves in a circle when it is in its natural place. [cf. Hoffman 1987, 76–83].

⁴⁰ 482.28 τῷ ἀκινήτῳ: scil. the Prime Mover.

⁴¹ 482.29–30: cf. *De caelo* 292a25–26.

⁴² 483.1 κόνισις: cf. *De caelo* 292a26.

⁴³ 483.4–6: in point of fact, Aristotle likens such a body to the Earth [cf. *De caelo* 292b15–20].

⁴⁴ 483.8–9: the Latin version of Themistius’ paraphrase [Landauer 1902, 120.8–16: cf. 119.38–120.4] asserts that the planets have their number of motions in proportion to their distance from the fixed sphere, which is hardly consistent with the terms of the first ἀπορία [but see 119.12–15].

⁴⁵ 483.10 (*De caelo* 292b3–4). Note «δύνασθαι» in an articular infinitive construction instead of «δύνανται». Aristotle does not actually say this, but it is a credible inference from what he does say.

- many things or many times, which is in fact very difficult. (Not only is it hard, say, for a knucklebone player ‘to throw 10,000 Chian or Coan knucklebones’—
- [15] it is written thus, as if knucklebones are large in both islands—it is in fact impossible; but ‘one or two is rather easy’).⁴⁶ But this is in fact fitting for those who are stronger, I mean, attaining the most complete good through a greater number [of actions]—for instance, if it were necessary to do [A] for the sake of [B] and [B] for the sake of [C] and [C] for the sake of [D], as [it is] necessary to learn one’s letters with a view to being able to engage in the sciences and [to do] this with a view to practicing philosophy and [to do] this with a view to assimilating to the divine.⁴⁷ Certainly, ‘it is easy’ also for
- [20] the weaker ‘to succeed in one or two [steps] but more difficult to the degree that it is through more [steps]’.⁴⁸ Thus, among living things that are generated,⁴⁹ as the actions of man are greatest in number because man can attain many goods (given that, for his part, he does many things, both managing them for the sake of other things and referring their benefit to himself),⁵⁰ so one must

⁴⁶ 483.13 (*De caelo* 292a29) ἡ Κῶνυς. The better mss for the *De caelo* have «Χίους» [cf. Moraux 1965, 82], but «Κῶνυς» as well as «Χίους ἡ Κῶνυς» are attested. For an account of these various readings and Simplicius’ text, see Moraux 1954, 158–159. Grossteste [Bossier n.d.a, 160.20–21] has ‘Kios ... vel Choos’; Moerbeke [Bossier n.d.b, 494.3], ‘Chios ... vel Koos’.

483.13 γράφεται ... οὕτως: Simplicius signals a textual remark [cf. Rescigno 2004–2008, 1.677].

483.13 (*De caelo* 292a30). The knucklebones (ἄστράγαλοι) were four in number, each marked on four of its six surfaces—two opposed surfaces had no value presumably because neither could support the knucklebone. The flat surface (τὸ χῖον) had the value 1; the concave surface, 3; the convex surface, 4; and the irregular surface (τὸ κῶν), 6 [cf. Longo 1962, 329–330; Moraux 1965, 161; Leggatt 1995, 249]. The shape of the knucklebones was such that it was easier to roll four 1s than four 6s [cf. Elders 1966, 236]—hence, presumably, the difference in value. Simplicius’ remark about the size of the knucklebones from Chios and Cos is misleading: Aristotle is surely thinking of the difficulty of attaining a particular outcome a very great number of times in succession.

⁴⁷ 483.17–19: Simplicius is here describing the program of learning and study in the late Athenian and Alexandrian Academies, the goal of which was salvation by assimilation to the divine (ὁμοιώσις πρὸς τὸ θεῖον) [cf. Wildberg 1999, 117].

⁴⁸ 483.20–21: cf. *De caelo* 292a32–b1.

⁴⁹ 483.21 ἐν τοῖς γενητοῖς ζῷοις. *Scil.* living beings unlike the heavenly bodies which are eternal and not generated (in time).

⁵⁰ 483.23–24: there seems to be a tension in Aristotle’s analysis between a thing’s having a great number of possible ends and a thing’s having complex ends, that is, ends that are to be reached by a series of subsumed ends each of which conduces to the ultimate end. Though the two need not be the same [cf. Sharples 1976], Simplicius seems to reduce the thesis about the greater number of actions and goods available to man (and hence, man’s superiority to the other animals) to a claim about the greater complexity of human action. Whether this is right depends in part on how one interprets *De caelo* 292b2–4. Certainly, what is relevant to Aristotle’s argument in 2.12 is the issue of the complexity of motion [cf. Landauer 1902, 120.16–38].

hold as well that the action of the [wandering] stars (that is, their motion) is many times more various than the [motion of the] others⁵¹ in comparison, because of their being able to attain a greater number of goods. And man too is more worthy of honor than other living things by virtue of his doing a greater number of things. [25]

The argument in its entirety would be as follows: if [bodies] performing a greater number of motions are worthier of honor, they perform a greater number of motions because of their succeeding at a greater number of things; but if [they are] inferior, [they perform a greater number of motions] because of their being unable to attain the best through a simple motion.⁵² [30] Consequently, even if opposites should belong to the same things and the same things to opposites, we will not be at a loss for a solution but will assign the reasons fittingly to the things [in question].⁵³ Thus, Aristotle says these things without reconciling them to the dignity of the gods.⁵⁴ Certainly, the argument is insecure; but it is one that provides the starting points of a solution, according to which we shall not be amazed both if what is more worthy of honor should be less active and if what is inferior should be less active.⁵⁵ [484.1]

After saying of man that he does many things, that is, so [very] many things as he acts for the sake of other things as well,⁵⁶ lest anyone suppose that this is the best [Aristotle] supplied '*what is perhaps in the best state has no need at all of action*'⁵⁷ and added the reason, rather the entire proof in fact, when he said that what is in the best state is that for which being this thing is being that for the sake of which [it is].⁵⁸ Certainly, the best is the goal of all things, that is, that for the sake of which all things are; and what acts is something else besides that for the sake of which [it acts]. In fact, [10] he supplied the explanation of this premise again when he said, '*for action*

⁵¹ 483.25 ἄλλων παρ' ἄλλα (*scil.* the fixed stars).

⁵² 483.28–30: on the form of the condition, see Smyth 1971, § 2359.

⁵³ 483.30–32: all the planets are inferior to the fixed stars in that they require more motions to attain the good.

⁵⁴ 483.32–484.1: that is, without saying which wandering stars are inferior or superior to one another in the current sense of these terms. Mueller [2005, 24] takes «διαίτων τῇ ἀξίᾳ τῶν θεῶν» to mean 'judging the worth of the gods', thus misconstruing the function of the dative. Cf. Moerbeke's 'non irreverens dignitati deorum' [Bossier n.d.b, 496.g].

⁵⁵ 484.1–2: e.g., the celestial sphere and the Sun (or Moon), respectively.

⁵⁶ 484.4: see *De caelo* 292b2–4.

⁵⁷ 484.5 (*De caelo* 292b4–5): note ἵσως—note Moerbeke's '*forte* autem optime habenti nihil opus est ...' [Bossier n.d.b, 497.5]—rather than «ὥς» [see Moraux 1965, 82].

⁵⁸ 484.6–7 (*De caelo* 292b5–6): Mueller [2005, 24] construes «τὸ εἶναι» as 'the essence', but in both occurrences it is simply a verbal noun meaning 'being', which is qualified by a predicate.

*depends on two [factors] since there is both that for the sake of which [there is action] and what is for the sake of this.*⁵⁹ For, if everything that acts does what it does on account of a desire of the good, the good would be one thing and what acts another. Thus, he infers in the second figure⁶⁰ that what is in the best state has no need of action, since what is in the best state *is* that for the sake of which [there is action] and what acts is not that for the sake of which [it acts].

- [15] And, after stating the [qualities] of the best by way of a middle [term], he attaches to what has been said before of man *'and, what is more, [the actions] of the other animals are fewer in number'*⁶¹ and what comes next [in the text].

- [20] He calls the action of plants, that is, the action concerning nutriment, *'slight'* and *'single, perhaps'*⁶² on the ground that they are not able to succeed in many [things]. (He has called the activity of the plant an *'action'* in its more common sense, since in the strict sense at least action is activity according to reason.)⁶³ But what comes next, *'since there is either some one [good] which they can attain'*,⁶⁴ he would surely say not of plants⁶⁵ but of agents in general, because either there is one particular thing set forth for the agent which it can attain (just as man in fact [can attain] one of the rather great number of things set forth for him), or, if there is actually not
- [25] one thing but [if] the things set forth are greater in number (as in fact they are for man), then *'these many things are conducive to the best'*⁶⁶ by virtue of the fact that all the other things incline to that [best thing] and are chosen because of it. But *'there is either some one [good]'* can also be applied in the case of plants when it is explicated in relation to *'there is perhaps some slight and single [action]'*⁶⁷ and means that either a plant does indeed have one

⁵⁹ 484.10–11 (*De caelo* 292b6–7) ἡ γὰρ πράξις ἐν δυσὶν: note Moerbeke's 'actio enim in duobus' [Bossier n.d.b, 498.1]. Moraux [1965, 82] prints «ἡ δὲ πράξις αἰεὶ ἐστὶν ἐν δυσὶν» ('for action always depends on two [factors]').

⁶⁰ 484.12–13: see *An. pr.* 1.5.

⁶¹ 484.16 (*De caelo* 292b7) καὶ δὴ καὶ τῶν: the mss of the *De caelo* have only «τῶν δ'» [see Moraux 1965, 82].

⁶² 484.19–20: see *De caelo* 292b8.

⁶³ 484.20–21: cf. 482.12–14.

⁶⁴ 484.21: see *De caelo* 292b8–9.

⁶⁵ 484.22–485.2: as Elders [1966, 238] points out, there is reason to doubt that *De caelo* 292b8–10 actually concern plants. Elders proposes that Aristotle is thinking of the heavenly bodies again [cf. 292b1].

⁶⁶ 484.26–27 τὰ πολλὰ ταῦτα πρὸ ὁδοῦ ἐστὶ πρὸς τὸ ἄριστον: cf. *De caelo* 292b9–10. Moraux [1965, 83] has «τὰ πολλὰ πάντα πρὸ ὁδοῦ ἐστὶ πρὸς τὸ ἄριστον».

⁶⁷ 484.27–28: see *De caelo* 292b8.

particular good which it can attain (just as man also [attains] each of the many goods that are his own), or, if a plant's goods seem to be many as well—say, feeding, growing in size, begetting [new plants]—all these are conducive to its single, most complete good, [a good] which is restricted in relation to the human [good]. [30] [485.1]

292B10–25

Thus, one [body] has or shares in the best,⁶⁸ (whereas another arrives at it⁶⁹ through a few [actions] and another through more [actions]; another, however, does not even try but is competent⁷⁰ to arrive at what is near the ultimate [good]. For example, if health is the goal, then one [body] is always healthy; another [is healthy] after it has lost weight;⁷¹ another, after it has run and lost weight; and another after it has done something else in fact for the sake of running so that its motions are more numerous; whereas another is unable to arrive at being healthy but only at running or losing weight and one or other of these is the goal for [these bodies]. Of course, it is best by far for all things to attain the former goal;⁷² otherwise, it is always better [for them] to the degree that they are nearer what is best.

In fact, for this reason, the Earth does not move at all and the [bodies] nearby⁷³ perform a few motions, since they do not arrive at the ultimate [good] but up to the [degree] which they can attain the most divine principle. The first heaven attains [this principle] directly through a single motion. And the [bodies] between the first [heaven] and the [bodies] farthest [from it] arrive (at [this principle], but do [so]) through more motions.⁷⁴

⁶⁸ *De caelo* 292b10: the Latin version of Themistius' paraphrase makes very clear that, for Aristotle, this best is not absolute but is defined in relation to intentions and aims [cf. Landauer 1902, 121.6 and 8–9].

⁶⁹ *De caelo* 292b11 ἀφικνεῖται: the mss have «ἀφικνεῖται ἐγγύς» ('arrive near') [cf. Grosseteste's 'attingit propinque' [Bossier n.d.a, 162.27]], but Moraux [1965, 83] deletes «ἐγγύς», which attenuates the point and does not appear subsequently in Aristotle's discussion, and notes that Simplicius [485.22] has only «ἀφικνεῖται» [cf. Moerbeke's 'hoc autem per paucos motus pertingit ad sui ipsius finem' [Bossier n.d.b, 503.7–8]]. Stocks has conjectured «ἀφικνεῖται εὐθύς» ('arrives directly'), perhaps because of its occurrence at 292b23 and in Simplicius' commentary [487.4]. Cf., e.g., Allan 1955, *ad* 292b11.

⁷⁰ *De caelo* 292b12 ἱκανόν.

⁷¹ *De caelo* 292b14 ἰσχνανθέν: lit. 'after it has been reduced'. Cf. Grosseteste's 'attenuatum' ('made thin or slender') [Bossier n.d.a, 163.1].

⁷² *De caelo* 292b18: *scil.* what is best.

⁷³ *De caelo* 292b20: *scil.* the Sun and Moon.

⁷⁴ *De caelo* 292b24: *scil.* the Sun and Moon [cf. 291b29–292a3].

De caelo 292b25 κινήσεων [Moraux 1965, 83]. Heiberg [485.4] follows A and prints «τῶν κινήσεων»; other mss omit «τῶν».

- [485.5] After stating that we should think of the heavenly bodies as [we do] of living and active [things] rather than as [we do] of things without soul,⁷⁵ and after supplying the distinctions between agents,⁷⁶ [Aristotle] reaches [the goal] set forth by explicating the solution of the problem that has been raised—as Alexander says, by using what was mentioned first for explicating the reason [why the planetary motions are distributed as they are], namely, the fact that, whereas for those things which are best there is no need of action, for some things [there is need] of a slight [action] in order to attain the best, and for others [there is need] of a greater [action]. Perhaps [Aristotle] also links up the second distinction, the one bringing to light [the fact] that a slight motion is not always better but is in fact sometimes worse than a greater [motion].⁷⁷ Thus, he says that neither the first nor the last of the things that are has need of action—the last, because it does not reach its goal proximately and the first, because it is not distinct from the good but has [the good] in accordance with its own being, that is, shares in it.⁷⁸ (In fact, he could be applying ‘*having*’⁷⁹ to the Goodness that is beyond Being, that is, to the One, and ‘*sharing*’⁸⁰ to the Intellect that is unified proximately with the Good or has a share in it. For a thing that presents [an attribute] in accordance with its own being is said to have [that attribute], whereas a thing that takes [the attribute] from another is said to share [the attribute].⁸¹ Certainly, that Aristotle actually has in mind something beyond Intellect and Being is clear when he says plainly in the closing parts of his book, *On Prayer*, that God is either Intellect or in fact something beyond Intellect.⁸²)
- [10]
- [15]
- [20]

⁷⁵ 485.5–6: *scil.* ὥς διανοοῦμεθα περὶ Cf. *De caelo* 292a18–22 and Comment 12.05, pp. 227–229.

485.5–10: see fr. 158a (Alexander) in Rescigno 2004–2008, 2.290.

⁷⁶ 485.6–7: cf. *De caelo* 292a22–b10.

⁷⁷ 485.10–12: see Comment 12.06, pp. 229–230.

⁷⁸ 485.12–16: cf. *De caelo* 292b10–13.

⁷⁹ 485.16: cf. *De caelo* 292b10.

485.16–22: Simplicius is here interpreting Aristotle through the lens of later Platonic thought.

⁸⁰ 485.17: cf. *De caelo* 292b10.

⁸¹ 485.18–19: the subjects of the two limbs of this sentence are «τὸ ... προβεβλημένον» and «τὸ ... λαμβάνον», and not «τὸ ἐν» and «ὁ νοῦς» as Mueller [2005, 26] would have it. Simplicius is making a lexical point.

⁸² 485.21 τοῦ Περὶ εὐχῆς βιβλίου. There is doubt that there ever was such a work by Aristotle: see Rist 1985 for a reconstruction of the history of this ‘text’. For a discussion of passages in which Aristotle mentions prayer (εὐχή), see Mayhew 2007.

485.21–22: see Ross 1955, 57.

One thing arrives through a slight number of motions at its own goal. But the goal is twofold: in one sense, it is what is the best of all things and the most complete; in the other, it is more particular.⁸³ Slight motion is also twofold: in one sense, it is as [a motion] that comprehends the multitude of motions even in itself and, because of this, attains the goal that is common and total; in the other, it is [a motion] that is part of the many and, because of this, is aimed at a particular [good]. It is also clear that the former [kind of slight motion] is better than many motions, while the latter [kind of slight motion] is inferior. Consequently, what attains its goal through a greater number of actions (that is, activities) would be a mean for what [attains its goal] through a few actions. [25]

And, because of this, the problem is solved, [I mean the problem,] ‘Why, given that the fixed [sphere] performs a single motion, do the [heavenly bodies] that are farther from it (the Sun and the Moon) perform fewer motions than the [bodies] that are higher and nearer the fixed sphere, whereas these [intermediate bodies] perform a greater number [of motions]?’ [The answer,] he says, [is] that, some of the [heavenly bodies] which perform a few motions are better than those which perform a greater number [of motions] and some are inferior. And which [of the two], and in which way, has been stated. But the last [body]⁸⁴ does not even try to attain its goal immediately. This is why it does not even move, but it is enough for it to come to what is near its goal.⁸⁵ [30] [486.1] [5]

Next, after clarifying what has been said through the example of health in which he presents ‘*losing weight*’ as becoming trim,⁸⁶ and after saying that attaining the most complete goal is best, otherwise, [it is attaining] what is as near as possible to that [goal],⁸⁷ he finally adapts what has been set out to what has been said by passing from the last to the first and then including those in between.⁸⁸ [10]

⁸³ 485.24 μερικώτερον: Grosseteste [Bossier n.d.a, 164.8] has ‘particularius’, but Moerbeke [Bossier n.d.b, 503.10] has the superlative ‘partialissimus’ (‘most particular’).

⁸⁴ 486.3–4: *scil.* the Earth.

⁸⁵ 486.5 εἰς τὸ ἐγγύς τοῦ τέλους: *scil.* some lesser good. Cf. 486.19–487.3.

⁸⁶ 486.7 τὸ ἱσχυανθῆναι: see *De caelo* 292b14.

⁸⁷ 486.7 (*De caelo* 292b13–17): ἀπέριτον: lit. ‘without excess parts’.

⁸⁸ 486.7–9: see *De caelo* 292b17–19.

⁸⁸ 486.9–10: cf. Landauer 1902, 121.24–27

et quemadmodum in his, ita etiam in caelestibus corporibus haec conspiciuntur, atque eo magis, quo primo principio propria extiterint. in hoc autem Aristoteles eo usque sermonem protulavit, quo usque ad speculationem terrae pervenerit.

In other words, he says, *‘for this reason the Earth does not move at all’*⁸⁹—not because it has its immobility for the same reason that the good (that is, its goal) [has immobility]. For, while [the good] was that for the sake of which moving objects move and had no need to move to itself,⁹⁰ the Earth (being farthest [from the fixed sphere]) does not by nature share in [the good] immediately; instead, by coming close (as it can) to those which do share in [the good] proximately, it also shares in [the good].

The [heavenly bodies] near the Earth perform a slight number of motions because they do not arrive at the ultimate goal (that is, the first and utterly complete Good) because they are partitioned from it. Rather, they move up to the point where they can share in the most divine principle. And they can [do this] partially.

Even if by *‘Earth’*⁹¹ he means Earth in the strict sense, by *“near”*⁹² it he would mean the sublunary elements above the Earth; whereas, if by *‘Earth’* he means everything beneath the Moon, by *‘near’* he would mean the Moon and Sun in that they perform few motions. The latter [reading] is in fact more appropriate to what has been said, since it is about these [bodies] that the problem has in fact been raised, namely, why, given that the fixed [sphere] performs a single motion, the [wandering stars] that are farther from it (the Sun and the Moon) do not always perform more motions, whereas these perform a slight number of motions and the intermediate ones more.

Now, if *‘a slight number of motions’*⁹³ did not refer to the Sun and Moon, what is most important for the solution of the problem would be missing. But if it does refer to the Sun and Moon, *‘they do not arrive at the ultimate [good]’*⁹⁴ seems hard [to interpret], unless then it means that, given that they come to be as rather particular beings,⁹⁵ they are not comparable to the utter perfection of [the ultimate Good], since he has said plainly that they share

⁸⁹ 486.11: see *De caelo* 292b20.

⁹⁰ 486.13 ἐπ’ αὐτό. Though one editor omits «ἐπ’» [cf. Mueller 2005, 27 and n88], this is the better reading because it actually makes the point [cf. 482.16–21, 484.6–14: see Moerbeke’s ‘non oportebat ad ipsum moveri’ [Bossier n.d.b, 506.6]]. See Landauer 1902, 121.28–31, where Themistius distinguishes what is best because it has its end in itself and a ‘lesser’ object which does not and so must *act*.

⁹¹ 486.19: see *De caelo* 292b20.

486.19–487.1: see fr. 158c in Rescigno 2004–2008, 2.292.

⁹² 486.20: see *De caelo* 292b20.

⁹³ 486.26: see *De caelo* 292b20–21.

⁹⁴ 486.28: see *De caelo* 292b21.

⁹⁵ 486.29–487.1 μερικώτερα γινόμενα: Simplicius indicates his own view that the heavens are in some sense generated. Cf. 487.6–10.

in the first principle according to their own due measures.⁹⁶ In other words, he says, *they share in the most divine principle up to the degree which they can*.⁹⁷

The first heaven, he says, attains the first principle ‘*directly*’⁹⁸ (that is, immediately) through a motion that is single in kind, because this single [motion] is inclusive, productive,⁹⁹ and comprehensive of all motions. That is to say, after it was first set in motion, the first heaven imitated the completeness of what is immobile through its complete motion; and it becomes just what that is through everlasting eternity, Plato would say, with [the motions] beneath it dividing the sameness of [the immobile] through all time.¹⁰⁰ [5] [10]

And if it also pleases anyone to fall back on stories of the gods, let him bear in mind that in these [stories] too the [wandering star] after the first heaven, most powerful Saturn, is the beginning of separation and division.¹⁰¹ But these [matters are for discussion] elsewhere.

He mentions, ‘*The [bodies] in between the first [heaven] and the last [bodies]*’;¹⁰² calling the fixed heaven¹⁰³ ‘*first*’ and the Sun and Moon ‘*last*’, since these are the extremities of the divine body. Thus, he says, the ones in the middle of these, since they are more encompassing,¹⁰⁴ approach the completeness of the first principle closer than the last, but they approach [it] [15]

⁹⁶ 486.30–487.2: cf. Elders 1965, 239–240.

⁹⁷ 487.2: the mss have «οὐ» instead of «ὄτου» [cf. Moraux 1965, 83]. This is a paraphrase of *De caelo* 292b21–22.

⁹⁸ 487.4: see *De caelo* 292b23.

⁹⁹ 487.6 ἀπογεννητική. The claim that the motion of the celestial sphere produces or generates the planetary motions might seem to work against the view that the planets’ longitudinal motion eastwards is an independent motion, that is, a motion in accordance with an unimpeded natural impulse [cf. 473.1–6]. But perhaps, for Simplicius, the celestial sphere ‘produces’ the planets in the sense that they derive from it by procession and subordination that peculiar balance of tendencies to move eastwards and westwards which constitutes the being of each and accounts for its characteristic motion eastward [473.7–474.6].

¹⁰⁰ 487.6–10. See Plato, *Tim.* 36b6–d6, 37c6–d7. Simplicius is here interpreting Plato’s comparison of the sphere of the fixed stars to a moving image of eternity. He also would seem to depart from Aristotle in treating the celestial sphere as something that was once set in motion and not as something always in motion.

487.7 τὸ παντελὲς τοῦ ἀκινήτου: *scil.* the Craftsman God (Δημιουργός).

¹⁰¹ 487.10–12: see Mueller 2005, 104n91. The language may also reflect Simplicius’ view of the *genesis* of the heavens: see 133n99.

¹⁰² 487.13–14: «ἐν μέσῳ» instead of «ἐν τῷ μέσῳ» [cf. Moraux 1965, 83]. Simplicius seems to find in *De caelo* 292b23–24 an opposition between first and last where I suspect that Aristotle is only opposing first and farthest.

¹⁰³ 487.14 τὸν ἀπλανῆ οὐρανόν: *scil.* the sphere of the fixed stars.

¹⁰⁴ 487.16 ὀλικώτερα (lit. ‘more universal’): *scil.* ‘encompassing more motions’.

through the division of motions¹⁰⁵ and not through a single motion as the first heaven [does]. Thus, [they approach it] through a greater number of motions which divide the single motion [of the first heaven] completely.¹⁰⁶

[20] This is why they are also said to approach where the single motion also leads them back.

It seems even to me¹⁰⁷ that, after he investigated all the heavenly motions, I mean, those extending the all-ness of immobile Unity, Aristotle discovered that the fixed [sphere] in performing its single motion is inclusive of all [motions], whereas all [the spheres] after it [perform] all [motions] in a divided sense, and that the Sun and Moon do not [perform] all [motions],
 [25] since they are not observed making stations or retrogradations or different phases, or advances and followings¹⁰⁸—this is why astronomers have in fact been satisfied with simpler hypotheses in explicating the causes of their phenomena. Thus, after hypothesizing that the motions represent actions¹⁰⁹

¹⁰⁵ 487.17–19 διὰ μερισμοῦ ... τελείως: for Simplicius, the motion of the sphere of the fixed stars is single in the sense that it encompasses all the other celestial motions, even that motion which it does not itself present to observation, the motion from west to east [see 133n99].

¹⁰⁶ 487.18–19: for Simplicius, the motion of the celestial sphere is not just communicated to the lower spheres, it is distributed or divided [cf. 473.7–474.6, 133n99]. In the *Timaeus*, however, the motion of the Same, which is the motion of the celestial sphere, is neither distributed nor divided: only the motion of the Different suffers this.

¹⁰⁷ 487.20–488.2: Simplicius here reconstructs how Aristotle came to formulate and solve the first ἀπορία. On his assumption that Aristotle was aware of the planetary stations and retrogradations, see Comment 12.07, pp. 230–248.

¹⁰⁸ 487.24 ὑποποδισμούς: in an astronomical context, this term signifies a retrograde motion (that is, a synodic, as opposed to a daily, motion from east to west) and is not found used in this way before Proclus [cf., e.g., *Hyp. ast.* 7.4]. Geminus, *Intro. ast.* 12.30 seems to be the earliest extant text to affirm that the Sun and Moon do not undergo retrograde motion. Moerbeke [Bossier n.d.b, 511.6] has ‘retrogradationes’.

487.24 διαφόρους φάσεις: a phase is a significant configuration of the planet with respect to the Sun. Thus, the different planetary phases presumably include as well such synodic phenomena as first and last visibilities in the morning or evening. They would also include the phenomena which we call phases of the Moon [cf. 547.13], though Simplicius typically designates these as φωτισμοί (illuminations).

487.25 ἀκολουθήσεις [cf. 488.7]. I have not found any earlier use of this term in connection with the planets. One possibility is that «καί» in «προηγῆσεις καὶ ἀκολουθήσεις» is explanatory and, thus, that the phrase should be rendered ‘advances (that is, followings)’, where ‘followings’ are motions that follow the leading signs. But, though this would work well for 487.23–25 (and would entail that the προηγῆσεις are retrograde motions), it would strain the syntax at 488.5–7 where «καί» serves mainly to connect elements in a list. In any case, whatever the ἀκολουθήσεις are, as Simplicius makes clear, they are characteristic only of the five planets and not of the Sun and Moon. Note that Moerbeke has ‘assequentias’ here and ‘consequentias’ a few lines later [Bossier n.d.b, 511.7 and 512.10].

¹⁰⁹ 487.27 πρακτικὰς ... τὰς κινήσεις.

and occur because of an assimilation to the Good, he says that the first heaven attains complete assimilation proximately to the immobile through one complete motion, whereas the spheres after it arrive at complete assimilation through all the divided motions, and that the Sun and Moon share in it to the extent that they can, since they do not perform all the [planetary] motions.¹¹⁰ [30] [488.1]

In this way, then, Aristotle has explicated his solution of the problem, after laying it out and granting that the planets perform motions that are many in kind not only because of their apparent direct motions,¹¹¹ but also [because of] their [apparent] retrogradations, stations, [their] different phases, advances, followings, and [their] various kinds of unsmoothness.¹¹² [5] In fact, those who hypothesize eccentric and epicyclic [motions] as well as those who hypothesize homocentric [motions] (the ones called turning [motions]) admit a greater number of motions [than one] for each [planet] in order that these [apparent motions] be saved.¹¹³ [10] The true account, of course, which accepts neither the stations [of the planets] or their retrogradations nor the additions or subtractions of the numbers in their motions (even if they evidently move in this way),¹¹⁴ does not admit hypotheses as

¹¹⁰ 487.27–488.2: again, Simplicius offers a late Platonic reading of Aristotle's argument.

¹¹¹ 488.5 προποδισμούς: this term is common in astronomical contexts from the first century AD onwards. It is also found in Proclus [cf., e.g., *Hyp. ast.* 7.4]. Direct motions are non-synodic motions from west to east, that is, in the direction opposite to the daily rotation of the celestial sphere. Moerbeke [Bossier n.d.b, 512.9] has 'directiones'.

¹¹² 488.7 ἀνωμαλίας: on the idea of 'smooth' motion, see Bowen 1999, 293–295.

¹¹³ 488.7 διὰ ... τὸ ταύτας σώζεσθαι: lit. 'for the sake of these [apparent motions]' being saved'.

488.8 πλείονας (a greater number ... [than one]): alt., 'a rather great number'.

488.9: Simplicius uses «ἀνελίττουσαι», Aristotle's term for the unwinding spheres in *Meta.* Λ.8, more generally of homocentric spheres whether winding or unwinding. Henry Mendell [2000, 91–93] supposes that all of Aristotle's nested rotating homocentric spheres came to be called ἀνελίττουσαι by synecdoche. If this is correct, then, in this context, all occurrences of «ἀνελίττουσαι» should be translated translated by 'unwinding'. But perhaps instead readers of Λ.8 were aware of an ambiguity in the verb «ἀνελίττω» itself when applied to rotational motion, much as there was an ambiguity in their usage of the verb «ἀναστρέφω», for example, and thus understood that «ἀνελίττουσαι» could mean either 'wind back or return to the original position' (where no direction of rotation is implied) or 'wind backwards'. In any case, to avoid confusion, I have, when it is appropriate, translated «ἀνελίττουσαι» and its variants by 'turning' rather than by 'unwinding': cf. Aujac et al. 1979, 138n1. Grosseteste [Bossier n.d.a, 167.9] translates «ἀνελίττουσαι» by 'regirativos'; elsewhere he uses 'regirantes' [Bossier n.d.a, 171.3 *et passim*]. Moerbeke [Bossier n.d.b, 513.3–4 *et passim*] translates it by 'revolventes'.

¹¹⁴ 488.11 τῶν ἐν ταῖς κινήσεσιν ἀριθμῶν: the allusion is to tabular numerical data recording the positions of the planets and the times when they occupy those positions, and, in particular, to the corrections to the mean values for their daily progress.

being the case.¹¹⁵ Rather, by drawing inferences from the substance [of the planets] it demonstrates that the heavenly motions are simple, circular, smooth, and orderly.¹¹⁶

- [15] But, since [people] were not able to grasp precisely how what happens is an appearance of their conditions only and not reality, they desired to discover on what hypotheses it would be possible to save the phenomena of the motions of the [stars] that are said to wander, by means of smooth, orderly, circular motions.¹¹⁷ Indeed, as Eudemus recorded in the second book of his *Astronomical History* and as Sosigenes (who took it from Eudemus) [also recorded], Eudoxus of Cnidus¹¹⁸ was the first of the Greeks said to lay hold of hypotheses of this kind, after Plato, as Sosigenes states, proposed for those who are serious about these matters the following question: 'By hypothesizing which smooth and orderly motions will the phenomena of the motions of the wandering [stars] be saved?'¹¹⁹
- [20] Thus, *if* the motions (which are greater in number in each case than the rather numerous wandering bodies)¹²⁰ are hypotheses, and *if* they are not proven to be so in truth—as the fact that different [people] hypothesize them in different ways makes clear—what need is there to seek in this way
- [25] the reason why the planets proximate to the fixed [sphere] perform more
- [30]

¹¹⁵ 488.12–13 οὐδὲ τὰς ὑποθέσεις ὡς οὕτως ἐχούσας προσίεται: Mueller's 'nor does it admit hypotheses of this kind' [2005, 28] mistranslates the Greek and wrongly suggests that there might be a hypothesis that is accepted in the true account. For Simplicius, what is at issue here is the very notion of astronomical hypothesis itself. See 136n16.

¹¹⁶ 488.12–14: this is a line of argument found in earlier Stoic writers such as Posidonius and Cleomedes [cf. Bowen and Todd 2004, 193–204; Bowen 2007].

¹¹⁷ 488.14–18: note that, as Simplicius sees it, this question is wrong-headed. What is needed is not an account that saves the phenomena but one that explains them.

488.15–16 πῶς αὐτῶν διακειμένων ... τὰ συμβαίνοντα (how what happens ... not reality): Moerbeke [Bossier n.d.b, 514.1–2] has 'qualiter ipsis dispositis ... accidentia' ('regarding their conditions themselves, what happens ...'). Grosseteste's version is similar [cf. Bossier n.d.a, 167.17–18].

¹¹⁸ 488.19: on Eudemus of Rhodes, see 98n10.

488.19: Eudoxus (–389 to –336) [cf. De Santillana 1940]. See also Bowen 2012b.

488.19–24 [cf. 422.14–24, 492.31–493.11]: for an analysis of this complicated report, see Knorr 1990, 319–320. It is worth recalling Simplicius' point [488.10–18: cf. 492.25–28, 510.2–3] that this whole line of investigation is misguided. The complexity of this sentence may be Simplicius' way of distancing himself from Sosigenes' report that Plato initiated it. Simplicius certainly does not buttress Sosigenes' report by citing any Platonic text. See pp. 61–67, 81–83.

488.20: Sosigenes (second century AD) was a Peripatetic philosopher and teacher of Alexander of Aphrodisias [cf. Hayduck 1899, 143.12–14, Bowen 2008c]. See Comments 12.08 and 12.25, pp. 248–251 and 278–283.

¹¹⁹ 488.21–24: see Comment 12.09, pp. 251–259.

¹²⁰ 488.25–26 τῶν πλανωμένων ... σωμάτων (the wandering bodies): *scil.* the planets themselves.

motions than the ones that are last, as though for each of the wandering stars there are in truth a greater number of bodies [than one] and because of this a greater number of motions?¹²¹

But, since we are obliged to hazard making these sorts of comparisons in general, perhaps¹²² it is not necessary for us to define the merits [of the planets] in regard to the distinction between their places but to say that each has been posted in the place where it benefits the universe. Thus, since bodies beneath the Moon do not have their own light but are illuminated from without, ‘the two lights of the cosmos’¹²³ have rightly, one might say, been stationed proximately above them, perhaps because [these lights] have the simplicity of their motions for what is better than what is composite.

[489.1]

For his part, Plato seems to say in his *Laws* that, whereas the planets evidently move thus in a variety of ways, they surely do not move in this way in truth.¹²⁴ But, in his *Timaeus*,¹²⁵ he concedes that their motion is more varied on the ground that they are in between things that are ordered in every respect and things that are disordered in every respect, and that because of this they have an ordered unsmoothness.¹²⁶ This is why in his *Laws* he also inveighs against those who predicate only wandering of them and who do not think that this [wandering] both shares in order and is theirs by nature.¹²⁷

[5]

[10]

Inasmuch as Alexander says flatly¹²⁸ in regard to these [arguments] that the four elements (that is, the sublunary ones) are without soul and lack

¹²¹ 488.27–30: on the text, see Comment 12.10, pp. 260–261.

¹²² 488.30 μήποτε: see 102n32.

488.31 εἰ (since). The obligation arises from the thematic questions of *De caelo* 2.10 and 2.12.

488.32 ἀξίας (merits): the solution to the first problem assigns merit on two divergent grounds: position (or proximity to the best) and activity [cf. esp. 482.16–26, 483.28–484.2, 485.30–486.19]. Cf. *Meta.* 1073b1–3.

¹²³ 489.2–3 οἱ δύο τοῦ κόσμου φωστῆρες: cf. 461.28–32. Proclus [*Hyp. ast.* 4.72: see also Kroll 1899–1901, 2.43.25 and 2.300.23] also calls the Sun and the Moon φωστῆρες. Such usage appears to go back at least to the first century BC, since it is attested in the *Septuagint* (3rd c. BC to early Christian era). It is not found in Plato and Aristotle.

¹²⁴ 489.5–7: see Plato, *Leg.* 821b3–822d1.

¹²⁵ 489.7–9: see Plato, *Tim.* 35a1–40d5.

¹²⁶ Cf. Proclus, *In Tim. ad* 39d–e [Diehl 1903–1906, 3.95.34–96.32].

¹²⁷ 489.9–11: see Plato, *Leg.* 822a4–8.

¹²⁸ 489.12 ἀνέδην: lit. ‘without restraint’ or ‘without ado’. Moerbeke [Bossier n.d.b, 517.9] has ‘inverecunde’ (‘impudently’), perhaps because Simplicius seems to take Alexander to be denying his interpretation of Aristotle’s notion of aether and the statement that the heavenly bodies should be viewed as possessed of soul and sharing in action [cf. 482.10–14]. See p. 78.

489.12–30: see fr. 158e in Rescigno 2004–2008, 2.293–294.

[15] any share in action,¹²⁹ who would not be amazed if things composed of a tiny portion of [these elements] are living things with souls, though they possess a being that is ephemeral (that is, altogether contracted into a brief [time]),¹³⁰ whereas such great portions of the universe, which are eternal in their entireties¹³¹ had not been judged worthy of soul by the Demiurge? For, even if [the four elements] are simple,¹³² there would be no need for them to be without soul, since, for their part, the heavens (which are also simple) have been given soul—even when each of [these four elements] as composed from the four [opposites] is what it is said to be by virtue of the predominance of one [opposite].¹³³

[20] But, if [the four elements] do not share in action because different ones do not act at different times (just as particular living things do), the heavens too always have the same pattern of activities.¹³⁴

And if [Alexander] thinks that the Earth is without life and soul because it does not move locally, first, we should be ashamed, if we say that plants made alive by the Earth live and are ensouled but that the Earth itself is [25] without life and soul.

Next, when Aristotle says that both Intellect and Soul are alive, he does not necessitate that they move locally. Even if the Earth, which is the ‘Hearth of the universe’,¹³⁵ is at rest, it has this action and activity. For, just as moving as an animal,¹³⁶ so too standing at rest as an animal is an action and an

¹²⁹ 489.12–13: for Alexander, nothing lacking a nutritive faculty can have a soul [Bruns 1887, 29.1–4]; thus, for him, none of the elements has a soul.

¹³⁰ 489.13–15: Simplicius seems to be thinking of insects such as the May fly.

¹³¹ 489.15–16: *scil.* the net amount of each element in the cosmos.

¹³² 489.17 ἀπλᾶ (simple): cf. 16.30–34.

¹³³ 489.19–20: thus, an element is fire, say, because of the predominance in it of the hot. What Simplicius calls elements here, Aristotle calls simple bodies (ἀπλᾶ σώματα): for him, the opposites are elements [cf. *De gen. et corr.* 331a20–b4]. For Simplicius, simple bodies are natural bodies that have a (single) source of natural motion in them—they are not simple *simpliciter*—and elements are the ultimate components of other bodies, which means that aether is not an element strictly speaking [cf. 4.34–5.4, 16.16–26, 17.20–32, 24.17–20].

¹³⁴ 489.21: for Simplicius, each part of the heavens acts in ways that constitute a regular, eternally recurrent pattern; and, like the elements, each is by nature never at rest or not acting.

¹³⁵ 489.26: «ἐστία τοῦ παντός» is found only in reports about those who thought that at the center of the universe, its hearth, was a fire: cf. [Plutarch], *Plac. philos.* 895e6–7; Stobaeus, *Anthol.* [Wachsmuth and Hense 1884, 1.22 § 1d.2–4]. Simplicius adopts the phrase but follows Plato [*Leg.* 955e6–7] in identifying the Earth as the hearth: cf. Galenus Gram., *Alleg. in Hesiod. theog.* [Flach 1876, 331.7–9].

¹³⁶ 489.27 ζωτικῶς: lit. ‘in a manner characteristic of life or of what is alive’. Moerbeke [Bossier n.d.b, 520a.1] has ‘vitaliter’.

animate activity. That is why the heavenly bodies move, whereas the Earth stands at rest and particular animals both move and stand at rest.

[30]

292B25–30

Concerning the problem (that there is a great multitude of heavenly bodies in the first motion, which is single, whereas each of the other [heavenly bodies] gets its own motions separately, one would reasonably think that this obtains primarily because of one thing. For one should understand that, regarding the living source of each [motion], there is a great superiority of the first in relation to the rest,¹³⁷

After he has set forth the two problems and solved the first, he goes after the second one which asks why the fixed sphere, though it is single and performs a single motion, has so great a multitude of heavenly bodies that it seems uncountable, with all performing one motion, namely, that of the fixed sphere; whereas each of the [heavenly bodies] that are said to wander gets its own motion in accordance with the sphere on which it is alone by itself. Then, in solving this problem in three or two arguments, he has stated the first from the superiority which the fixed [sphere] has to the other spheres.¹³⁸

[489.33]

[490.1]

[5]

Certainly, even if all [the spheres] have both life and status as a source [of motion],¹³⁹ *one should bear in mind that there is in fact belonging to the first [sphere] a superiority of both life and origination [of motion].¹⁴⁰* The

¹³⁷ *De caelo* 292b29–30: see Comment 12.11, pp. 261–262.

¹³⁸ 490.5 ἐπιχειρήμασι: an ἐπιχείρημα is often for Aristotle a dialectical argument [see Bolton 2009]. Themistius distinguishes two arguments [Landauer 1902,]: *De caelo* 292b25–30 and 292b30–293a11 [Landauer 1902, 122.25–123.9, 123.9–30].

490.5 εἴρηκεν. Cf. Moerbeke's 'primum dictum' [Bossier n.d.b, 520b.1]: several mss have have «εἰληπται» ('has taken') or «εἰληφεν» ('took') instead. Grosseteste has 'primum assumptum' [Bossier n.d.a, 170.1].

490.5–6: for Themistius [Landauer 1902, 122.25–28], this superiority is assigned to the sphere's principle of life, that is, its soul. In the first instance, however, Aristotle attributes superiority to the *motion* of the first (or fixed) sphere. But this is a minor point, since the claim about the superiority of the first sphere follows readily [cf. Landauer 1902, 122.34–35, 123.3–4]. More important is that in moving to the second problem Simplicius tacitly switches from talk of the planets and fixed stars as though they were alive to the claim that the spheres carrying these heavenly bodies are alive. This reflects the same switch in 292b28–293a2 [cf. Leggatt 1995, 250].

¹³⁹ 490.7 καὶ ζῶν καὶ ἀρχικὸν ἀξίωμα.

¹⁴⁰ 490.7–8 ἐννοῆσαι χρὴ ... καὶ ζῶν καὶ ἀρχής: a paraphrase of 292b28–30. Simplicius' text, apparently, does not preserve the hendiadys [see Comment 12.11, pp. 261–262] and lacks the troublesome «ἐκάστης».

- [10] immediate kinship [of the fixed sphere] to the primary acting and moving cause¹⁴¹ makes clear the superiority of its power, as do its being inclusive of all the other [spheres], its carrying round the other [spheres] by itself, and, still further, its attaining the most complete good entirely through one simple motion and in almost no time (if one bears in mind its magnitude). Consequently, perhaps one would wonder more rightly at the opposite, namely, if [this sphere] which is superior by so much, nevertheless has some
- [15] whole-number ratio of power to the other [spheres], [I mean, some ratio] which the multitude of [heavenly bodies] moved by it [has] to each one of the [heavenly bodies] fixed in the other [spheres].

292B30–293A4

and this [superiority] would turn out to be reasonable.¹⁴² (For the first [motion], which is single, causes many of the divine bodies to move; whereas the [motions of the individual planets], which are many in number, each [cause] only one body [to move], since any one of the wandering [stars] performs a greater number of motions [than the fixed stars]. In this way, then, nature both makes things equal and produces a certain order; that is, by giving many bodies to one motion and many motions to one body.

- [490.19] There is no need, they say, for us to run his statements together by conjoin-
- [20] ing this [argument]¹⁴³ to the [statements] above, but we should accept it as a second argument. Certainly, [Aristotle] does say that ‘*the first*’¹⁴⁴ motion (the motion of the fixed [stars]), though it is one in number, causes many

¹⁴¹ 490.9–10 τὸ πρῶτον ποιῶν τε καὶ κινῶν αἴτιον: *scil.* the Prime Mover, to be identified with the Craftsman God (Δημιουργός) [cf. 487.6–10, 489.12–17], given that the celestial sphere is its hypostasis [see pp. 54–56].

¹⁴² *De caelo* 292b31 κατὰ λόγον (reasonable) [cf. 97n5]: alternatively, ‘in accordance with our argument’. See Pellegrin 2004, 261 (‘une supériorité proportionnelle’) with 439n13.

¹⁴³ 490.19 τοῦτο: *scil.* ἐπιχειρημα. In his division of the text into *lemmata*, Simplicius would seem to treat *De caelo* 292b30–293a4 as offering a separate argument. But note his reservations at 490.5 (‘in solving this problem in three or two arguments’) and 490.29–491.11. In truth, these lines in the *De caelo* simply explicate how the superiority of the first motion to all the others is reasonable or contributes to the first solution of the problem at hand, depending on how one reads κατὰ λόγον [cf. 140n142]. In either case, they do not constitute a separate argument but are part of the first. Cf. Landauer 1902, 123.5–9 *quod autem rationi consonum sit, ut ita res se habeat, hinc profecto ostenditur* ... (‘But because it is consistent with reason that the matter [*scil.* the superiority of the fixed sphere] is so, from this it is in fact pointed out ...’) to present 292b30–293a4; and 123.9–10 *et praeterea* (‘And furthermore’) to introduce 293a4–11.

490.19–491.3: see fr. 159a in Rescigno 2004–2008, 2.296–301.

¹⁴⁴ 490.20: cf. *De caelo* 292b31.

'of the divine bodies'¹⁴⁵ to move in accordance with its own single motion; whereas the motions of the wandering [stars], since they are many in number for each star, cause one body belonging to many spheres to perform many motions. That is to say, each of the wandering stars performs a greater number of motions [than the fixed sphere] in that it is carried by a greater number [of spheres] (which are called turning [spheres]). *In this way, then*, [25] he says, 'nature equalizes' even this great a superiority 'and produces a certain order by giving [the] many bodies'¹⁴⁶ of the fixed stars 'to the one motion' of the fixed [sphere] 'and [the] many motions' of the wandering star 'to one body'.¹⁴⁷

Indeed, interpreters who put this argument down as distinct on its face urge not conjoining it to the previous one. But, perhaps, if it is *not* conjoined [30] with that one, [his assertion,] 'and this would turn out to be reasonable',¹⁴⁸ is unintelligible. For what is 'this', if he did not use [it] with reference to [491.1] superiority?¹⁴⁹ Certainly, saying 'this' is the position, order, and apparent inequality [of the first sphere in relation to the others], as Alexander states, treats the missing [part] of the explanation as extensive.¹⁵⁰

Now, perhaps, in saying that the superiority of the fixed [sphere] is great in relation to the wandering [stars] and through this solving the problem, [5] [Aristotle] is thereupon pointing out that this superiority is in fact equalized somehow by divine craftsmanship through proportionality. For as the

¹⁴⁵ 490.21: cf. *De caelo* 292b32.

¹⁴⁶ 490.25–26: cf. *De caelo* 293a2. The mss for Simplicius have «ταύτη οὖν» where those for the *De caelo* have «ταύτη τε οὖν».

¹⁴⁷ 490.26–28: cf. *De caelo* 293a3–4.

¹⁴⁸ 490.31: cf. *De caelo* 292b30–31. Moerbeke has 'significans' for «συμβαίνουσα» [Bossier n.d.b, 522.3]. The reading in the lemma is unclear: Bossier [n.d.b, 520c] has 'accidens' but notes that both 'accidens' and 'significans' are attested in the mss.

¹⁴⁹ 491.1: in *De caelo* 292b29–30, the antecedent of 'this' («ἥδε») has to be «ὑπεροχήν».

¹⁵⁰ 491.1–3: the Latin version of Themistius' paraphrase has

hic est litterae intellectus, in hoc autem non videtur Alexander recte sensuisse, siquidem ficta quaedam, aliunde adsumpta, suae explicationi adiecit.

This is the meaning of the text. But Alexander does not seem to have perceived [the matter] rightly in this, since he adds certain false(?) [propositions] taken from elsewhere to his explanation. [Landauer 1902, 123.21–23]

Note, however, that Rescigno's fr. 159c replaces the last clause with

... siquidem in suae explicationis margine colligit id secundum imaginationem dictum esse.

... since in the margin of his own explanation he has deduced that this has been stated in accordance with imagination. [Rescigno 2004–2008, 2.298]

single motion of the fixed [sphere] stands to the many stars moved by it, so the single wandering star stands to the many motions that it performs.

- [10] Of course, if one does not accept in this way what is said but as a distinct argument completely on its own, it is in fact on no account capable of overturning [the argument] stated before it, since that one alleges superiority as a cause, whereas this one alleges equalization.¹⁵¹

293A4–11

And further, the other motions have a single body [to move]¹⁵² because (the motions before the last [motion] (that is, the [motion] which has the [wandering] star [to move]) cause many bodies to move, given that the last sphere moves by virtue of being fixed in many spheres and each sphere is a kind of body.¹⁵³ Thus, the work of that [last sphere] must be shared in common: for, whereas each sphere itself has by nature its own characteristic motion, this [motion] is, as it were, added and) the power of every limited body is in relation to a limited [body].¹⁵⁴

- [491.15] This is another argument (either the second or third), which supplies on the basis of the spheres called turning [spheres], the explanation of the fact that

¹⁵¹ 491.10 μήποτε (never, on no account). Mueller [2005, 31] takes «μήποτε» as ‘perhaps’ [cf. Moerbeke’s ‘forte’ [Bossier n.d.b, 523.5] and Grosseteste’s ‘forsitan’ [Bossier n.d.a, 171.22]]. But just how could the argument from superiority ‘refute’ the argument from equalization?

¹⁵² 491.12 καὶ ἔτι διὰ τὸδε ... φόροι [Moraux 1965, 84]: some mss of *In de caelo* do have «φοραί» in the lemma but the better ones read «καὶ ἔτι διὰ τοῦτο ... σφαίραι» (‘And further, the other spheres have a single body’). Grosseteste [Bossier n.d.a, 171.25] and Moerbeke [Bossier 1975, ad loc.] have ‘aliae sphaerae’.

¹⁵³ *De caelo* 293a4–8: Aristotle’s point is that each planetary motion *qua* proper is the motion of but one body; yet this proper motion may still set other bodies in motion incidentally, that is, by virtue of the nesting of homocentric spheres.

De caelo 293a8 σῶμα τι: on the qualification, see Comment 10.02, pp. 201–202.

De caelo 293a8 τυγχάνει ὄν = ἐστὶ (is), as often in Aristotle [cf. Liddell, Scott, and Jones 1968, s.v. τυγχάνω II].

¹⁵⁴ *De caelo* 293a10 πρόκειται: *scil.* added to the motions below it. Thus, all the superior spheres contribute to the motion of the last sphere and the motion that each contributes is, therefore, shared in common by all lower spheres.

De caelo 293a10–11: cf. 274b33–275b4. There is no mention in Simplicius’ commentary (or in Moerbeke’s translation) of the last four lines of 2.12:

Concerning the heavenly bodies that perform circular motion, we have stated what sorts of things they are both with regard to their substance and their shape, and we have spoken about their motion and order. [De caelo 293a11–14]

Grosseteste [Bossier n.d.a, 172.4–6] supplies them.

the wandering [spheres] each have a single star, whereas the fixed [sphere has] such a great number [of stars].

Thus, he says that the sphere possessing the single star said to wander ‘*moves by virtue of being fixed*’¹⁵⁵ in many spheres (called turning [spheres] or, as Theophrastus calls them, starless [spheres]),¹⁵⁶ given that it is the last [sphere] of the entire system¹⁵⁷ of spheres—for example, of the [spheres] which cause Saturn or Jupiter or one of the other [planets] to move. [20]

Of course, simple motion is by nature characteristic to each of these spheres (the [sphere] possessing the [wandering] star and the ones containing this [sphere]); and the variety (that is, unsmoothness) of the [wandering] star as it seems to move directly and to go retrograde, to add and subtract in its numbers, and to stand still is added from outside. In fact, [this variety] is brought about by the turning [spheres] because each of them moves, as was said, according to its own characteristic motion and because each one in accordance with its own proper motion causes the [sphere] possessing the [wandering] star to move differently. [25]

Thus, since each sphere is a body,¹⁵⁸ and since in each system [of planetary spheres] to the outermost (which moves with the fixed [sphere]) is assigned in addition to its characteristic motion [the further task of] causing all the other spheres contained by it to perform in common the same motion that it performs, it would be difficult¹⁵⁹ for [this outermost sphere] to cause both so many bodily spheres and the sphere possessing the single star to move, if [that sphere] no longer possessed one but many [stars], as the fixed [sphere] indeed does. Aristotle indicated the difficulty through the statement, ‘*The power of every limited body is in relation to a limited [body]*.’¹⁶⁰ To explain— [30] [492.1] [5]

if what causes motion had *unlimited* power, it would be no trouble to put

¹⁵⁵ 491.20: cf. *De caelo* 293a7.

¹⁵⁶ 491.17–18 = Theophrastus, fr. 165B in Fortenbaugh et al. 1992. Cf. [Alexander], *In meta.* 1073b18–19 [Hayduck 1891, 703.10–24]. The author of this commentary is usually taken to be Michael of Ephesus [see Praechter 1906; Hadot 1987c; Luna 2001, 59–65, 197–212] but note the dissent in Tarán 1987, which argues that the author antedates Syrianus.

¹⁵⁷ 491.19: Theophrastus of Eresus (Lesbos) (–371 to –287), associate of Aristotle. He became head of the Lyceum when Aristotle withdrew from Athens in –322 on the death of Alexander the Great. For discussion of Theophrastus and his place in late Platonism, see Baltussen 2008, 93–99.

¹⁵⁸ 491.20 τῆς ὅλης τάξεως.

¹⁵⁹ 491.28–29: Simplicius omits Aristotle’s qualification at 293a8, which is not that surprising since, for him, all heavenly bodies, visible and invisible, rotate: see Comment 10.02, pp. 201–202.

¹⁵⁹ 492.1 ἐργῶδες (difficult): alternatively, ‘laborious’.

¹⁶⁰ 492.4–5: cf. *De caelo* 293a10–11.

any number of objects beneath it to move.¹⁶¹ But, since a body which is limited has *limited* power, this power must be relative to what is limited and commensurate with it, and not relative to a [body] of just *any* sort. Thus, if
 [10] it goes beyond the kinetic power of one sphere to move so many bodies¹⁶² by itself, [and] if the sphere possessing the single [star] possessed many stars too, the task would be truly difficult.

It seems to me that this argument advances as though in dependence on the [preceding one]¹⁶³ which states that there is a great superiority of the fixed [sphere] in relation to the wandering [spheres], since what is there to prevent [the following]—that just as the fixed [sphere] causes both all
 [15] the stars on it and all the spheres contained by it to move together with itself, so too the outermost of the turning [spheres] causes both the turning [spheres] beneath it and the sphere which no longer possesses the single star but many to move? [Nothing,] unless, therefore, it makes a difference that the fixed [sphere] (which subsists with the fixed stars and performs its own motion) thus carries round together the [spheres] contained by it,
 [20] and that the [sphere] possessing the wandering star would make its motion due to another more difficult for the mover if it possessed a multitude of stars.¹⁶⁴

What is difficult [in this] is not that those bodies have weight—Aristotle, after all, has denied this in a demonstration¹⁶⁵—but that there must in every way even among these objects be a commensurability of the mover to what is moved. For this reason, Aristotle has made his demonstration from [commensurability].

[25] One should understand that this argument too advances as though in dependence on astronomical hypotheses bearing on turning [spheres] that are truly the case, although [these hypotheses] have no necessity, as I

¹⁶¹ 492.5–6 οὐδὲν ἂν ᾗν πρᾶγμα ὅσαοὺν ὑποβάλλεν αὐτῷ πρὸς τὸ κινεῖσθαι: cf. Aujac et al. 1979, 159 ‘point ne serait besoin de rien placer au-dessous pour transmettre le mouvement’; Mueller 2005, 32 ‘nothing could overcome it with respect to being moved’.

¹⁶² 492.10 *scil.* the spheres beneath the outermost sphere in each planetary system [cf. Aujac et al. 1979, 159m].

¹⁶³ 492.12 ὡς ἐπ’ ἐκείνῳ προΐέναι: cf. Aujac et al. 1979, 159. Mueller [2005, 32] misreads this as ‘goes forward (only) against’—‘against’ would require «ἐπὶ» with accusative—and goes astray in rendering 492.12–20. Cf. 492.25–26.

¹⁶⁴ 492.12–21: thus, Simplicius implies, if increasing the number of bodies on the innermost sphere would make the task of all the planetary or turning spheres more difficult, it follows that the fixed sphere, which moves an almost countless number of stars [cf. 481.16–18] as well as all the spheres beneath it, must surely be superior in power, even in relation to the outermost sphere of each planetary system.

¹⁶⁵ 492.22: cf. *De caelo* 269b18–270a12.

have also said earlier,¹⁶⁶ since different [people] in fact save the phenomena through different hypotheses. It would be appropriate for our accounts of the heavens and the heavenly motions to speak briefly about these hypotheses too, given that when they are hypothesized each [of their proponents] maintains that he saves the phenomena. [30]

It was in fact stated earlier¹⁶⁷ also that Plato (who unequivocally assigned the circular, the smooth, and the ordered to the heavenly motions) put forward a question for mathematical scientists¹⁶⁸—Given what hypotheses will it be possible that the phenomena of the wandering [stars] be saved by means of smooth, circular, and ordered motions?¹⁶⁹—and that Eudoxus of Cnidus was the first to focus on hypotheses by means of spheres [called turning [spheres]]. Callippus of Cyzicus (who was a schoolmate of Polemarchus, a pupil of Eudoxus) came to Athens after [Eudoxus] and lived with Aristotle,¹⁷⁰ correcting with Aristotle Eudoxus' discoveries and [493.1] [5]

¹⁶⁶ 492.27: see 488.3–14, 25–30. Cf. 510.2–3.

¹⁶⁷ 492.31: see 488.14–24 and 422.14–24.

492.31–497.5 = Eudoxus F124 in Lasserre 1966.

¹⁶⁸ 493.2 τοῖς μαθηματικοῖς: see Comment 10.04, pp. 203–204.

¹⁶⁹ 493.2 τίνων ὑποτεθέντων, δι' ὁμαλῶν ... κινήσεων: lit. 'what things having been hypothesized, [...] through smooth ... motions'. Mueller's 'by making what hypotheses about uniform ... motions' [2005, 33] gets the question wrong.

¹⁷⁰ 493.5–8: this passage is the only surviving source from antiquity of biographical information about Callippus. See Bowen 2012a.

493.6 Πολεμάρχῳ συσχολάσας: Mueller's 'who studied with Polemarchus' [2005, 33 and n119] is ambiguous: the prefix «συν» entails that «συσχολάσας» take the dative of *accompaniment* [cf. Smyth 1971, §1545] and so may indicate here a relation of fellow students rather than one of pupil and teacher. This certainly is the usage of the verb that one finds in Strabo, Plutarch, Diogenes Laertius, and Athenaeus, for instance.

Note also «συσχολάσας τοῖς ὑπὸ Εὐκλείδου μαθηταῖς» ('et Euclidis discipulorum consuetudine ... uteretur') at Pappus, *Coll.* 7.35 [Hultsch 1877, 678.38 with 679]: cf. Ver Eecke 1982, 507 'il avait ... consacré ses loisirs aux disciples d'Euclide'. The text, however, should actually read «σχολάσας τοῖς (ὑπὸ) Εὐκλείδου μαθηταῖς» [Jones 1986, 121]. Jones' 'had studied ... under the people who had been taught by Euclid' [1986, 120] is unduly interpretative: the literal sense is 'who devoted his time (or himself) to the students of Euclid'.

493.6 γνῶριμῳ (pupil: cf. Diels 1882–1895, 99.13–15): Simplicius may actually mean that Polemarchus was a member of Eudoxus' inner circle of students, that is, those advanced students who were instructed by the master himself and who bore some of the responsibility for teaching others (the ἀκροαταί) [cf. Watts 2006, 29–32, 52, 156–157, 160–161]. Moerbeke has 'Eudoxi noto' ('who was known to Eudoxus') [Bossier 1975, 3.1.17].

Polemarchus is otherwise unknown except for the additional citation at 505.21 [see Comment 12.34, pp. 293–294]. There is no support for Neugebauer's inference [1975, 668] that Polemarchus observed an annular eclipse.

493.6 μετ' ἐκείνον. Presumably, then, some time after Eudoxus' death in –336 and, hence, after –334, when Aristotle returned to Athens from Macedonia. Heath [1913, 212] takes the antecedent of «ἐκείνον» to be Polemarchus.

supplementing [them], since the hypothesis of turning [spheres] (which hypothesizes the turning [spheres] as homocentric with the whole [universe] and *not* eccentric as later [thinkers suppose]),¹⁷¹ was pleasing to Aristotle, who thought that all heavenly [bodies] must move about the center of the universe.

Now, Eudoxus and his predecessors thought that the Sun performs three motions, since it is brought round from east to west with the sphere of the fixed [stars], since it performs by itself the opposite [motion] through the 12 zodiacal [constellations], and, third, since it is displaced obliquely at the [circle] through the middle of the zodiacal [constellations].¹⁷² (This [third motion] was in fact ascertained from [the Sun's] not always rising at the same place in the summer and winter solstices.)¹⁷³ Thus, because of this, they said¹⁷⁴ that [the Sun] moves in three spheres (which Theophrastus called starless (on the ground that they possess no star) as well as compensating in relation to the [spheres] lower down, and turning in relation to the [spheres] higher up).¹⁷⁵

Certainly, since there were three motions for [the Sun], it was impossible that the motions in opposite directions be caused by the same thing, given

¹⁷¹ 493.11: Simplicius appears to be thinking of accounts of the planetary theory in Aristotle, *Meta.* A.8 that rely on eccentric spheres. See Theon, *De util. math.* 3.31–32: cf. 3.34 [Hiller 1878, 178.3–184.23: cf. 189.7–18] which includes an account in which the planet is fixed on an ‘epicyclic’ sphere.

¹⁷² 493.14–15 ἐπὶ τοῦ διὰ μέσων τῶν ζῳδίων (at the [circle] through the middle of the zodiacal [constellations]). For the distinction of zodiacal signs (which are divisions of the zodiacal circle and thus have length but not breadth) and zodiacal constellations, see Geminus, *Intro. ast.* 1.1–3. There is no reference to the zodiac here. Mueller sometimes misreads «ὁ διὰ μέσων τῶν ζῳδίων scil. κύκλος» as ‘the middle of the signs of the zodiac’ [2005, 33, 34, *et passim*].

¹⁷³ 493.15–17: the summer and winter solstices are here the days of the year in which the daytime is longest and shortest respectively, rather than the points on the eastern horizon at which the Sun rises on these days. Cf. [Alexander], *In meta.* 1073b20–21 [Hayduck 1891, 703.23–28]. Later writers quantify the obliquity of this third sphere [see Heath 1913, 199–200]. See Comment 12.12, pp. 262–264.

¹⁷⁴ 493.18 ἔλεγον (they said): not «ἔλεγεν» (‘he said’) as Mueller [2005, 33] has it.

¹⁷⁵ 493.17–20 = Theophrastus, fr. 165C in Fortenbaugh et al. 1992. My ‘compensating’ is intended to capture «ἀνταναφερούσας» (lit. ‘bringing back(wards) in (re)turn’). Grossetete [Bossier n.d.a, 174.24–25] has ‘contraferentes’ and Moerbeke [Bossier 1975, 3.2.10], ‘contra-referentes’.

This citation of Theophrastus is inept and should probably be deleted as a not too clever marginal gloss that has crept into the text at an early stage. In the first place, only the first two of the Sun’s spheres are actually starless: the third carries the Sun. Next, when the term ‘compensating’ is explained at 504.4–15, it is clear that it designates unwinding spheres, not turning spheres. Moreover, turning spheres are superior spheres (such as the first two of the Sun) which impose their motion on the planet.

that for their part neither the Sun nor the Moon nor any of the stars moves by itself, but all move by virtue of being fixed on a rotating body.¹⁷⁶ If, then, [the Sun] made its revolution in longitude¹⁷⁷ and its displacement in latitude¹⁷⁸ in one and the same time interval, two spheres would be sufficient—one [25] [would be] the [sphere] of the fixed [stars] which rotates to the west and the other, [the sphere] which winds to the east about an axis which is fixed in the former [sphere] and at right angles to an oblique circle along which the Sun would be held to make its progress.¹⁷⁹ But, since [this] is not the case, instead, since [the Sun] goes round the [zodiacal] circle in one time interval and makes its displacement in latitude in some other, it is necessary in fact [30] to take in addition a third sphere, so that each motion supplies one of the [Sun's] apparent [motions].

Thus, given that the spheres were, therefore, three [in number] and all [494.1] homocentric with one another and the universe, [Eudoxus] hypothesized¹⁸⁰ that the one containing the [other] two rotates around the poles of the cosmos in the same direction as the [sphere] of the fixed [stars], making its return [to the same position] in the same time interval as this [sphere]; that the one which is smaller than this [outer sphere], but larger than the one remaining, rotates from west to east about an axis (as has been said)¹⁸¹ [5] which is at right angles to the plane of the [circle] through the middle of the zodiacal [constellations]; whereas the smallest sphere also rotates in the same direction as the second, though about a different axis which should be understood to be at right angles to the plane of some oblique great circle which the Sun is held to describe with its own center as it is moved by the smallest sphere on which it is in fact fixed. Then, he posits that

¹⁷⁶ 493.22–23 ἐνδεδημένα τῷ κυκλικῷ σώματι: lit. ‘fixed on a body that moves in a circle’.

¹⁷⁷ 493.23 κατὰ μήκος (in longitude): *scil.* its annual motion eastward along the zodiacal circle or ecliptic. This technical usage was well established by Simplicius’ time.

¹⁷⁸ 493.24 εἰς πλάτος (in latitude). Since well before Simplicius, «πλάτος» designated vertical displacement above or below a given reference circle. Moreover, when the reference circle is the zodiacal circle [cf. Toomer 1984, 21] as it is here, this term is best translated by ‘latitude’. This certainly suits Simplicius’ usage here and at 495.5 [but see Mueller 2005, 33]. See 148n183 on 495.5–8.

¹⁷⁹ 493.27–28 λοξῷ ... ῥήμιος: *scil.* the zodiacal circle. The author of the commentary on Aristotle, *Meta. E–N* notes that Eudoxus designated as fixed the first sphere of each planetary system as well the celestial sphere [Hayduck 1891, v, 703.12–23 = F123 in Lasserre 1966]. See also 268n129.

¹⁸⁰ 494.2 ὑπέθετο (he hypothesized): the subject is plainly Eudoxus [cf. Aujac et al. 1979, 162]. Mueller [2005, 34] errs in taking the verb as a passive form: cf. 494.9–12 ... τίθεται ... ἐκ τοῦ Περί ταχῶν αὐτῷ γεγραμμένου συγγράμματος.

¹⁸¹ 494.4: cf. 493.26–28.

- [10] the direct motion¹⁸² of this [third] sphere is slower by far than the [direct motion] of the [sphere] containing it ([a sphere] which is intermediate in size and position), as is clear from the treatise *On Speeds* written by him.¹⁸³

Thus, the greatest of the spheres causes both the remaining [spheres] to rotate in the same direction as the fixed [stars] because it carries in itself the poles which belong to the [second] and because [the second sphere carries] [15] the [poles] of the third [sphere] (which carries the Sun); that is, because [the second sphere], in that it contains the poles (of the third sphere) in itself, likewise causes both [the third sphere] and together with it the Sun to rotate (with itself) in the direction that *it* is made to go around. And, thus, it results that [the Sun] appears moving from east to west. And if the two spheres (the intermediate and the smallest) were by themselves in fact [20] immobile, the revolution of the Sun would occur in the same time interval as the rotation of the cosmos. But as it is, since these [spheres] rotate in the opposite direction, the Sun's return from one rising to the next comes later than the time interval [just] mentioned.¹⁸⁴

These [remarks] apply to the Sun. But, in the case of the Moon, he arranged some things in the same way and other things differently. That is to say, [Eudoxus arranged] that the spheres which carry [the Moon] also be [25] three [in number] because it appeared to have in fact three motions. And of these [spheres, he arranged] that one be [the] sphere which moves in the same way as the [sphere] of the fixed [stars]; and that a second be [the sphere which moves] in a direction opposite to this as it rotates about an axis at right angles to the plane of the [circle] through the middle of the zodiacal [constellations]¹⁸⁵ (just as in the case of the Sun too). [He also arranged] that the third be [a sphere which] no longer [moves] just as in the case of the Sun [495.1] because, though it is alike in position, it is actually not alike in motion, since it moves instead in a direction opposite to the second [sphere] and in the same direction as the first while performing a slow motion, as it rotates, in

¹⁸² 494.10 ὑπόληψιν (direct motion): lit. 'falling behind' [cf. 495.10]. The term indicates that direct motion is here being viewed as a gradual falling behind the fixed stars in their daily motion westward. On supposing that this falling behind is just apparent, see 476.10–27 [pp. 108–109].

¹⁸³ 494.9–12: see Figure 12.03, p. 188 and Comment 12.13, p. 264.

¹⁸⁴ 494.20–22 [cf. 501.17–21]: in other words, if the Sun and a fixed star rise together on one day, the Sun will rise later than the star on the next day: see Figure 12.04, p. 188. See also Comment 12.14, pp. 264–265.

¹⁸⁵ 494.28: reading «διὰ μέσου τῶν ζωδίων» with A and Moerbeke [Bossier 1975, 3.4.14 *per medium animalium*] rather than «διὰ μέσων τῶν ζωδίων» with DEFc [cf. Aujac et al. 1979, 163].

fact, about an axis which is at right angles to the plane of the circle which is understood to be described by the center of the Moon at an inclination to the [circle] through the middle of the zodiacal [constellations] by an amount [5] equal to the greatest displacement in latitude for the Moon. It is evident that the poles of the third sphere should be separated from the [poles] of the second by an arc on the great circle understood to be through both [poles], [where this arc] is as long as half of the breadth [of latitude]¹⁸⁶ that the Moon travels.

Thus, he hypothesized the first sphere because of [the Moon's] circuit from east to west; the second because of its apparent direct motion beneath [10] the zodiacal [constellations]; and the third because it evidently does not take its place in the same points of the zodiacal [circle]¹⁸⁷ when it is farthest north and farthest south [of this circle], but because these sorts of points always change position in the direction of the leading zodiacal [signs].¹⁸⁸ That is why, then, he also [hypothesized] that this sphere also moves in the same direction as the [sphere] of the fixed [stars], and that its motion to the west¹⁸⁹ was slow by virtue of the fact that the change in position of the points [just] mentioned during each month is very small indeed.¹⁹⁰ [15]

This, then, is the extent [of the discussion] of the Moon too. But, regarding the five planets, Aristotle, who sets out [Eudoxus'] view, says that these move by means of four spheres, of which the first and second are the same in that they have in fact the same position as the first two spheres for the Sun and [20] for the Moon. That is to say, the one is a sphere containing all the [spheres] for each of the [planets] which rotates about the axis of the cosmos from east to west in the same time interval as the [sphere] of the fixed [stars]; and the second, which has its poles in the first, makes its rotation contrariwise from west to east about the axis (or poles) of the [circle] through the [25] middle of the zodiacal [constellations] in the time interval in which each of the [planets] is held to traverse the zodiacal circle.¹⁹¹ Accordingly, in the

¹⁸⁶ 495.8 τοῦ πλάτους (breadth of latitude): cf. 147n178. See also Comment 12.15, p. 265.

¹⁸⁷ 495.11 ἐν τοῖς αὐτοῖς τοῦ ζῳδιακοῦ σημείοις (in the same points of the zodiacal [circle]): *scil.* at the same longitude.

¹⁸⁸ 495.13 ἐπὶ τὰ προηγούμενα (in the direction of the leading zodiacal [signs]): *scil.* in the direction of the daily rotation, that is, westwards. See Comment 12.16, pp. 265–266.

¹⁸⁹ 495.15: reading «ἐπὶ δυσμάς» with DEFc and Moerbeke [Bossier 1975, 3.5.13 'occidentem'] rather than A's «ἐπὶ δυσμῶν».

¹⁹⁰ 495.13–16: see Figure 12.05, p. 189 and Comment 12.17, pp. 266–268.

¹⁹¹ 495.25 τὸν ζῳδιακὸν κύκλον (the zodiacal circle): *scil.* the circle though the middle of the zodiacal constellations, *not* 'the zodiac' [Mueller 2005, 35].

495.25–26 ἐν ᾧ χρόνῳ: *scil.* the zodiacal or sidereal period.

case of the star of Mercury and of the [star] of Venus, he says¹⁹² that the [rotation] of the second sphere is completed in a year; that in the case of Mars, in two years; that in the case of Jupiter, in 12 years; and that in the case of Saturn, which the ancients used to call the star of Helios, 30 years.¹⁹³

- [30] The two remaining spheres are presumably disposed as follows.¹⁹⁴ The
[496.1] third sphere for each [planet] has its poles on the [circle] through the middle
of the zodiacal [constellations]—the one understood to be on the second
sphere for each [planet]—and rotates to south from north and from south to
north¹⁹⁵ in the time interval in which each [planet] comes from [one] phase
to the next phase [of the same type] as it passes through all configurations
in relation to the Sun. (Scientists, in fact, call this time interval a synodic
[5] period.)¹⁹⁶ This [period] is different for each [planet], which is why the

¹⁹² 495.27 φησι (he says): strictly speaking, the speaker reported should be Aristotle; but no such remark by Aristotle actually survives. So perhaps Simplicius now means Eudoxus: cf. 496.6. Note, however, that, while Grosseteste has 'ait' [Bossier n.d.a, 177.21], Moerbeke has 'aiunt' ('they say') [Bossier 1975, 3.6.3].

¹⁹³ 495.25–29: see Comment 12.18, pp. 268–269.

495.28–29: cf. Geminus, *Intro. ast.* 1.23–30; Cleomedes, *Cael.* 1.2.20–43 (with Bowen and Todd 2004, 39n9). As Bouché-Leclercq [1899, 66–70] suspected, such usage goes back to the Babylonians: on Saturn as the Star of Helios (Helios = the Sun), see MUL.APIN 2.1.39 and 64 with Hunger and Pingree 1989, 147 and the references in Tarán 1975, 89n409.

According to Leonardo Tarán [1975, 308–309], though there are ms. readings which entail a reference to the star of Helios at [Plato] *Epin.* 987c4–5, it is more likely that the author wrote 'star of Saturn'. Thus, the earliest text extant in Greek to mention the star of Helios would be P. Par. gr. 1. [col. 5 (first half of second century BC: Bowen 2008b)]. See Tarán 1975, 89 and n410 for further references.

¹⁹⁴ 495.29 ὡς πῶς ἔχουσιν (are presumably disposed as follows): cf. Mueller's 'are arranged more or less in the following way' [2005, 35]. See Comment 12.19, pp. 269–271. For the configuration, see Figure 12.06(a), p. 190.

¹⁹⁵ 496.1–2 ἀπὸ μεσημβρίας ἐπὶ τὰς ἄρκτους ἐπιστρέφεται: cf. Moerbeke's 'meridie ad ursas volvitur' [Bossier 1975, 3.6.8–9]. But Grosseteste's translation supports the view that the text should be «ἐπὶ μεσημβρίαν ἀπὸ τῶν ἄρκτων καὶ ἀπὸ μεσημβρίας ἐπὶ τὰς ἄρκτους στρέφεται» [Bossier 1987, 297]. Cf. 496.24–25.

¹⁹⁶ 496.4 οἱ ἀπὸ τῶν μαθημάτων (lit. 'those from the sciences'): these are presumably the μαθηματικοί (mathematical scientists) at 493.2, for instance. See Comment 10.04, pp. 203–204.

496.4 διεξόδου χρόνον: lit. 'time interval of passage or traversal'. I have not found any instances of the usage that Simplicius reports here. Moerbeke's text, 'quod diexiodi, quasi pertransitionis, tempus mathematici vocant' [Bossier 1975, 3.6.11] glosses 'diexiodi'.

Whereas the sidereal period of a planet is the time that it takes to return in longitude to a fixed star, its synodic period is the time that the planet takes to return to the same synodic phase, where this phase is defined by the planet's position in relation to the Sun. Thus, the synodic period is, for example, the interval between a planet's successive oppositions or successive first visibilities in the morning.

rotation of the third sphere is also not in the same time interval for all. But, just as Eudoxus thought, for the star of Venus [this rotation occurs] in 19 months;¹⁹⁷ for the star of Mercury, in 110 days; for the star of Mars, in eight months and 20 days; and for the star of Jupiter and of Saturn, in very nearly 13 months for each.¹⁹⁸

Thus, the third sphere moves in this way and in this great a time interval.¹⁹⁹ [10]
The fourth sphere, however, which in fact carries the [wandering] star, rotates about [the] poles of an oblique circle, poles characteristic to each [planet]. However, it makes its rotation in the same time interval as the third [sphere], as it moves from east to west in the direction opposite to the [motion of the third].²⁰⁰ This oblique circle is said by [Eudoxus] to be inclined to the greatest of the parallel circles in the third sphere by an amount that is not equal and not [in] the same [direction] in all [cases].²⁰¹ [15]

Thus, it is evident that the [first sphere], which rotates in the same way²⁰² as the [sphere] of the fixed [stars], causes all the remaining spheres to rotate in the same direction because they have their poles in one another, so that [it causes] both the sphere carrying the [wandering] star and the [wandering] star itself [to go round in the same way as the sphere of the fixed stars]. And for this reason then, each of the [planets] will have risings and settings. The second sphere will afford [the planet]²⁰³ its progress [20] beneath the 12 zodiacal [constellations], since it rotates about the poles of

¹⁹⁷ 496.6–7: according to Heath [1913, 210–211], assigning a synodic period to Venus that is more than 1.5 times its zodiacal period makes it impossible to account for the fact that Venus has retrograde motion.

¹⁹⁸ 496.7–8: the synodic period assigned to Mars—260 days, assuming 30-day months—is about one third of what it should be. As Heath [1913, 208–210: cf. Neugebauer 1975, 681] explains, there is no way to obtain a satisfactory account of Mars' retrogradations using the value that Simplicius gives for Mars' synodic period.

¹⁹⁹ 496.6–9: see Comment 12.20, pp. 271–272.

²⁰⁰ 496.10–12: cf. 496.29–497.2. On the claims that the third and fourth spheres move in opposite directions and have the same period, see Yavetz 1998, 231–233.

²⁰¹ 496.14 πρὸς τὸν μέγιστον τῶν ... παραλλήλων: *scil.* to the equator of the third sphere. The parallel circles are defined by the sphere's rotation.

496.15 οὐκ ἴσον οὐδὲ ταὐτὸν ἐφ' ἀπάντων. It is not clear what Simplicius means by «ταὐτὸν» here, since it does not seem in apposition to «ἴσον». I have construed it to mean 'in the same direction', the idea being that Simplicius may be thinking that the intersection of the equatorial circles of the third and fourth spheres will define a diameter, and that the direction of this diameter in the plane of the equatorial circle of the third sphere will depend on the orientation of the arc defined by the poles of the third and fourth spheres.

²⁰² 496.15 ὁμοίως: *scil.* in direction and speed.

²⁰³ 496.20 αὐτῷ παρέξεται: Mueller's 'the second sphere will make its passage' [2005, 36] overlooks «αὐτῷ» and misreads «παρέξεται».

the [circle] through the middle of the zodiacal [constellations] and causes the two remaining spheres and the [wandering] star to rotate with it in the direction of the following zodiacal [signs],²⁰⁴ in the time interval in which each is held to complete the zodiacal circle. The third sphere, which has its poles on the [circle] through the middle of the zodiacal [constellations] in the second [sphere], as it rotates from south to north and from north to south, will cause the fourth [sphere] (which also bears the [wandering] star on itself) to rotate with it and will, further, be the cause of [the planet's] motion in latitude. However, not by itself alone. The reason is that, [if the third sphere were the *sole* cause of the planet's motion in latitude,] in so far as the [wandering] star is subject to this sphere and reaches the poles of the [circle] through the middle of the zodiacal [constellations] it would also come to be near the poles of the cosmos.²⁰⁵ But, as matters stand, the fourth sphere, by rotating about the poles of the oblique [circle] belonging to a [wandering] star²⁰⁶ in a direction opposite to the [motion of the] third [sphere] from east to west, and by making their circuit²⁰⁷ in the same time interval [as the third sphere], will deny [the star's] passing farther beyond the [circle] through the middle of the zodiacal [constellations],²⁰⁸ and it will allow the [wandering] star to describe about this same circle [the curve] called a hippopede by Eudoxus.²⁰⁹ Consequently, the [wandering] star will also seem to be displaced in latitude by an amount equal to the width of this curve—the very [point] on which they criticize Eudoxus.²¹⁰

²⁰⁴ 496.19–20 ἐπὶ τὰ ἐπόμενα τῶν ζωδίων: *scil.* in the direction opposite to that of the daily rotation, that is, eastwards.

²⁰⁵ 496.27 ἐπὶ ταύτῃ: see Smyth 1971, §1689.2c.

496.27–28: given two spheres, if the inner has its poles in the equator of the outer, then the poles of the outer sphere are in the plane of the equator of the inner. Simplicius thus makes explicit that the planet is on the equator of its carrying sphere. See Comment 12.21, p. 272.

496.28–29: this does not happen—of the seven ancient planets, Mercury travels farthest from the zodiacal circle, its greatest latitude being 7°. Cf. 501.30–502.2.

²⁰⁶ 496.29–30: τοῦ τοῦ (τοῦ) ἀστέρος λοξοῦ κύκλου ... πόλους: *scil.* the poles of the circle described on the fourth sphere by the planet as this sphere rotates.

²⁰⁷ 497.1 τὴν στροφὴν αὐτῶν (their circuit): *scil.* its own rotation and the revolution of the planet fixed on it.

²⁰⁸ 497.1 ἐπὶ πλεόν (farther): that is, farther than it goes in fact.

²⁰⁹ 497.3 ἵπποπέδην. Note that in affirming that the hippopede is defined about the zodiacal circle, Simplicius again makes clear what is never stated explicitly, namely, that he takes the planet to be situated on the equator of the fourth sphere. Cf. 496.27–29. See Comment 12.22, pp. 272–273.

²¹⁰ 497.4–5: Heath [1913, 202] demonstrates that the width of one loop of the hippopede

This is the construction of spheres according to Eudoxus which takes 26 spheres in all for the seven [planets], six for the Sun and Moon, and 20 for the five [planets].

Concerning Callippus, Aristotle has written the following in [book] *Λ* of his *Metaphysics*:

*Callippus posited the same arrangement of spheres as Eudoxus, that is, the same order of distances; and he assigned the same number [of spheres] to the star of Jupiter and the star of Saturn each. But he thought that two spheres should be added for the Sun and for the Moon, if one is going to account for the phenomena, and one for each of the remaining planets.*²¹¹ [10]

Thus, according to Callippus, there are in all five times five and two times four [spheres], that is, 33 spheres. There has neither survived a treatise of Callippus stating the explanation of these spheres that should be added nor has Aristotle added it. But Eudemus has recorded concisely the phenomena for the sake of which [Callippus] thought that these spheres should be added: for he states that [Callippus] says that, if in fact the time intervals between the solstices and equinoxes differ by as much as Euctemon and Meton thought, the three spheres are not sufficient for either one to save the phenomena because of the unsmoothness clearly evident in their motions.²¹² And Eudemus has related concisely and clearly for what purpose [15] [20]

(its length being extended along the zodiacal circle) is the maximum latitude (πλάτος) that the planet attains. See also Neugebauer 1953, 229.

497.5: it is not clear who 'they' are; but their point appears to be that, when the planet does in fact seem to describe loops in the heavens, the width of these loops does not define the planet's maximum latitude: see Figure 6, p. 25. But if this is right, one wonders how they learned it.

²¹¹ 497.9–13: *Meta.* 1073b32–38.

497.10: τουτέστι ... τᾷς: this phrase, which appears in [Alexander] *In meta.* 1073b32–33 [Hayduck 1891, 704.9–10], is usually athetized by modern editors of Aristotle's treatise. It seems to be a gloss that assumes a computation of the sort found in Ptolemy's *Hypoth. plan.* All Aristotle does is to posit an ordering of the spheres: in fact, given his project, there was no reason to cast this as an ordering of the planetary distances from the Earth. Indeed, given the complexity of his arrangement, this would not have been a trivial project.

497.13: Heiberg has «μέλλοι», and «ἀνὰ μίαν»: the better mss of Aristotle's *Meta.* have «μέλλει» and just «μίαν», respectively [cf., e.g., Ross 1953, ad loc.].

²¹² 497.20: Euctemon and Meton were apparently contemporaries engaged somehow in astronomical studies in Athens of the fifth century BC. They are not clearly distinguished in the ancient sources [cf. Rehm 1949, col. 1340; Neugebauer 1975, 623 and n12; Bowen 2012c]. In P. Par. gr. 1 col. 23, it is reported that Euctemon posited astronomical season lengths of [93], 90, 90, and 92 days starting with the vernal equinox in a year of presumably 365 days. For a detailed study of the testimony concerning their work, see Bowen and Goldstein 1988.

497.20–21 οὐχ ἱκανὰς ... ἐκατέρω (not sufficient for either one): *scil.* for the Sun and the Moon.

497.21–22: the solstices and equinoxes mark out the astronomical seasons and are defined

[Callippus] added the one sphere which he added in [the case of] each of the three planets: Mars, Venus, and Mercury.²¹³

- [25] After reporting Callippus' view about the turning spheres, Aristotle inferred [that]

*is necessary, if all [the spheres] when put together are going to account for the phenomena, that for each of the wandering [stars] there be other spheres fewer in number by one, the unwinding spheres, that is, [the spheres] which always restore in position to the same point the first sphere of the [wandering] star stationed below, since only in this way is it possible that every] motion of the planets be produced.*²¹⁴

[498.1]

Now, since Aristotle had stated these matters concisely in so clear a manner,²¹⁵ Sosigenes praised his keenness of mind and tried to discover the need for the spheres added by him. And [Sosigenes] states that [Aristotle] says that these [spheres], which [Aristotle] calls unwinding [spheres], must be added to his hypotheses for two reasons:²¹⁶ in order that the fixed [sphere] for each [planet] and the [spheres] beneath it have their proper position, and so that there be the proper speed in all [spheres]. In other words, it was necessary that, for its part, the [sphere] similar to the [sphere] of the fixed [stars] <<(or to any other sphere)>> move round the same axis as that [sphere]

by the Sun's motion alone. So this explanation is at best partial, given that the Moon's motion is independent of the Sun's.

²¹³ 497.22–24: Schiapparelli holds that this explanation has dropped out of the received text and that one should thus show a lacuna after this sentence. Another possibility, however, is that, though Simplicius is using a source that did report Eudemos' account of Callippus' addition of the extra planetary sphere for each of Mars, Venus, and Mercury, he declined to give it; or that his source reported only the existence of a clear explanation. In any case, if the text has been disturbed here—note also «συντόμως» at 497.17, «συντόμως καὶ σαφῶς» at 497.24, and «συντόμως οὕτως σαφῶς» at 498.2—yet another possibility, I suppose, is that a negative particle «οὐ» has been omitted in this last sentence due to some copyist's error and that it should be negated. That is, Simplicius' original point may have been that Eudemos did *not* explain why Callippus added the extra spheres for Mars, Venus, and Mercury, at least in a way that he, Simplicius, could understand. Consistent with this is the hesitation registered at 504.20–22 in supposing that Callippus saved the phenomena by adding the spheres which he is said to have added: cf. 165n268.

²¹⁴ 497.26–498.1: *Meta*. 1073b38–1074a5. Heiberg has «εἰς ταῦτ' ἄποκαθιστώσας» [497.28], where the better mss of Aristotle's treatise read «εἰς τὸ αὐτὸ ἄποκαθιστάσας» [cf. Ross 1953, ad loc.] Moerbeke [Bossier 1975, 3.9.7] has 'ad idem'. On the following discussion of the unwinding spheres [497.24–504.3], see Comment 12.23, pp. 273–277.

²¹⁵ 498.2 συντόμως οὕτως σαφῶς: Heiberg follows A which omits «καὶ», though DEF have it. Moerbeke [Bossier 1975, 3.9.9] has 'brevider ita plane'.

²¹⁶ 498.5 ταῖς ὑποθέσεσιν: the systems of spheres for each planet attributed to Eudoxus and Callippus are astronomical hypotheses [see Chapter 2].

and complete its rotation in the same time interval, none of which can occur without the addition of the spheres mentioned by Aristotle.²¹⁷

[10]

For clarity's sake, [Sosigenes] says, let us make the argument in the case of the spheres carrying the [star] of Jupiter. Now, if we should fit the poles of the first of Jupiter's [spheres] in the last of the four [spheres] of Saturn ([the sphere] in which [Saturn] is also fixed), in what way could these [poles] remain on the axis of the sphere of the fixed [stars] when, for its part, the [sphere] carrying them rotates around another axis that is oblique? But surely they must at least remain on the axis [first] mentioned²¹⁸ in the case of the outermost motion, if the sphere rotating about them really is going to receive the disposition of the sphere of the fixed [stars]. Now, moreover, since three of the spheres carrying the [star] of Saturn are made to rotate together by one another and the first [sphere]—[these spheres] also possessing, of course, their own particular proper speed—the motion of the fourth would not be some simple motion but one sharing in all the [motions] above [it]. Indeed, it will be demonstrated that, when [spheres] move in the opposite direction, something is subtracted from the speed belonging to them²¹⁹ because of the [sphere] which turns [them] at the same time; and that, when [spheres] rotate together, something is added by the motion which goes through to them from the sphere above, because of their characteristic motion.²²⁰ Consequently, if the first of the [spheres] of Jupiter really should be fixed in the sphere carrying the [star] of Saturn and have its own proper speed for going back to the same position again in a rotation of the cosmos, the motions of the spheres above [it] will not permit it to have this speed but there will be some addition, since these [spheres] in fact move westwards while that one moves by itself in the same direction as well.

[15]

[20]

[25]

[499.1]

The same argument [holds] in the case of the next [spheres of Jupiter] as well, since their motion will be compounded more and more and their poles will go beyond their proper position. But, just as we said, neither of these results should occur.²²¹

²¹⁷ 498.5–10: on the text, see Comment 12.24, pp. 277–278.

498.10–499.1: what follows now is at the least a paraphrase of a passage from some work by Sosigenes. Mueller [2005, 37–38] supposes that Simplicius' citation extends to 499.15. But 499.3–4

δεῖ δέ, καθάπερ ἔφαμεν, οὐδέτερον τούτων συμβαίνειν.

But just as we said, neither of these results should occur.

refers back to 498.1–10 in which Simplicius is still speaking in his own voice. The use of «ἔφαμεν» ('we said') tends to support this conclusion: when Simplicius wishes to signal that 'we say' comes from Sosigenes, he adds «φησὶν» [see 501.1].

²¹⁸ 498.16 ἐπὶ τοῦ εἰρημένου ἄξιοнос: *scil.* the axis of the sphere of the fixed stars [498.14].

²¹⁹ 498.22–23 αὐταῖς τάχους ὑπάρχοντος: *scil.* their characteristic or proper speed.

²²⁰ 498.24: cf. 500.22–501.11.

²²¹ 499.3–4: cf. 498.1–10.

- Thus, [Aristotle] conceived of ‘*the unwinding [spheres], that is, [the spheres] which always restore in position to the same point the first sphere of the [wandering] star stationed below*’,²²² so that this would not occur and so
- [5] that he would not encounter anything erroneous in consequence of this at least. For, certainly, he also spoke precisely²²³ in revealing both of the reasons why he introduced them, namely, through his saying ‘*which unwind*’ in respect to the restoration of motion²²⁴ to its proper speed, and through
- [10] his having stated ‘*which always restore in position to the same point the first sphere of the [wandering] star stationed below*’ in respect to the permanence of the poles in their proper [place]. (The position of the carrying spheres is understood in accordance with these [poles], since they alone remain in place.)²²⁵ But he said that the first sphere of the [wandering] star stationed below is restored by the [unwinding spheres of the wandering star above], since all the [features] of the next spheres are saved when this [first sphere]
- [15] takes its proper position and its proper speed because of the unwinding.

Sosigenes demonstrated that these [results] follow, after he set out some [propositions] useful for the argument. The following is a brief exposition of these [propositions].²²⁶

- If there are two homocentric spheres, for instance, *DE* and *ZH*,²²⁷ and if they are contained from outside by another [*AB*] which is either at rest or wraps them round,²²⁸ and if [the spheres *DE* and *ZH*] move in directions opposite to one another and through equal time intervals (that is, at the same speed),
- [20]

²²² 499.5–7: *Meta.* 1074a2–4.

²²³ 499.7 κατὰ λέξιν εἶπων: lit. ‘spoke literally’.

²²⁴ 499.8–9 τὴν τῆς κινήσεως ἀποκατάστασιν: ‘le mouvement de rotation’ [Aujac et al. 1979, 170].

²²⁵ 499.11–12 κατὰ τούτους ... μένουσι: cf. Moerbeke’s ‘mansionem polorum in oportuno; secundum hos enim motarum sperarum positio intelligitur’ [Bossier 1975, 3.11.11–12]. However, Aujac et al. [1979, 170n1] propose bracketing this, claiming that it is an inappropriate gloss inserted into the text. But perhaps they do not see that the poles in question (κατὰ τούτους) are those of the fixed (or first carrying) sphere: they have ‘c’est en effet par rapport aux pôles que l’on définit la position des sphères tournantes puisque ce sont les seuls points immobiles’, which is true but beside the point. Mueller [2005, 38 and n156] likewise overlooks «κατὰ τούτους».

²²⁶ 499.17–500.14: cf. [Alexander] *In meta.* 1074a3–4 [Hayduck 1891, 704.23–705.6] for an anonymous version of these theorems.

²²⁷ See Figure 12.07, p. 191.

²²⁸ 499.19: reading «περιειλούσης ἐκεῖνας» (‘wraps them round’) with Heiberg. Both Moerbeke [Bossier 1975, 3.11.15] and Grosseteste [Bossier n.d.a, 181.27–28] have ‘ab alia sive manente sive circumducente illas’. Aujac et al. [1979, 171.10] read «περιαγομένης» with DE. F has «εἴτε κινουμένης εἴτε μενούσης τῆς περιεχούσης» (‘by another containing sphere that is either in motion or at rest’) [cf. Mueller 2005, 39 and n159].

[then] all the points in the contained [sphere, *ZH*] will always be at the same position in relation to the containing [sphere, *AB*], as if it were in fact at rest.

For, when the [sphere] *DE* moves as though from *A*²²⁹ to *B*, if the smaller sphere *ZH* only rotated with it²³⁰ and did not move in the opposite direction, it would be seen that, as *D* is at some time beneath *B*, so too is *Z* which moves with *D* (that is, in the same time interval). But, since the [spheres] in fact move together and the [sphere] *ZH* moves in the opposite direction to the [sphere] *DE*, [the sphere *ZH*] undoes as much when it moves in an opposite direction as it adds when it moves in the same direction [as *DE*]. And it results that, when *D* is beneath *B*, *Z* is beneath *A*, just as it appeared from the beginning. [500.1] Consequently, what has been proposed is true.

Thus, if the [sphere] *AB* is at rest, what has been proven is clear; namely, that, given the manner in which both [spheres] are laid down,²³¹ the inner [sphere], which goes round with the outer [(*scil.* middle) sphere] and moves in the opposite direction, always has the same position in respect of the same points,²³² and that it does not [have the same relative position] either when it only goes round with [the middle sphere] or when it only moves in the opposite direction.²³³

But then, if the [sphere] *AB* were also moving either in the opposite direction or in the same direction as the second sphere *DE*, the results will be the same regarding the points of the third [sphere] *ZH* (which moves with the [sphere] *DE* and moves in the opposite direction likewise [as before]).²³⁴ [5]

²²⁹ 499.22 ὥς ἀπὸ τοῦ *A*: lit. 'seemingly in the direction from *A*'. Cf., e.g., Moerbeke's 'ut ab *A* in *B*' and 'ab *A* velut ad *B*' [Bossier 1975, 3.11.18 and 3.12.11–12].

²³⁰ 499.23 συνεπιστρέφετο (rotated with it). There are several senses in which one sphere (*A*) may be said to rotate (or move round with) another (*B*):

- *A* and *B* rotate at the same time;
- *A* and *B* rotate at the same time and in the same time (i.e., they have the same period);
- *A* and *B* rotate at the same time and in the same direction;
- *A* and *B* rotate at the same time, in the same time, and in the same direction.

Simplicius' usage of such συν-compounds tends to the second and fourth meanings [see, e.g., 499.23 συνεπιστρέφετο, 499.24 συμφερόμενον, 499.25 συμφέρονται, 500.2–3 συμπεριφερομένην, 500.7 συμφερομένης, 500.8 συνεπισπώσης, 500.11 συνεπιστρέφειν, 500.19 συμπεριαγωγήν], and relies on context to convey the precise meaning.

²³¹ 500.2 καὶ ὅπως ἀμφοτέρων ὑπαχόντων *scil.* σφαιρῶν: a reference to the configuration of spheres under discussion. For «ὑπάρχω» as equivalent to «ὑπόκειμαι», see Liddell, Scott, and Jones 1968, s.v. ὑπάρχω B.II. Heiberg marks «καὶ ὅπως» as corrupt. Aujac et al. [1979, 172] replace it with «σφαιρῶν». Mueller [2005, 39 and n161] proposes 'and it is clear that if both things hold and the inner sphere ...', thus making one wonder what the two things are.

²³² 500.3 τοῖς αὐτοῖς ... σημείοις: *scil.* points on the third and outermost sphere.

²³³ 500.4 μόνον συμφερομένην ... μόνον ἀντιφερομένην: «μόνον» signals instances when the motion of the innermost sphere is *not* performed in the same time interval as that of the middle sphere.

²³⁴ See Figure 12.08, p. 192.

[10] For, when the sphere *AB* has been turned from *A* as though to *B* and draws with it the [sphere] *DE* so that *D* comes to *E*, if the middle sphere *DE* moves by itself either in the opposite direction to the [sphere] *AB* or in the same direction at any speed whatsoever in regard to the [sphere] *AB* but in the same time interval as the [sphere] *ZH*, it will make point *Z* go to one or the other side of *A* on account of²³⁵ its causing the third [sphere] to rotate with it. But the third sphere, since it moves in the opposite direction, will again make *Z* beneath *A*. And since this always happens, all the points on the sphere *ZH* will be beneath the same points of the sphere *AB*.

[15] Now, then, what was proposed has been proven on the assumption that the [three] spheres move about the same axis. But the same argument [applies] even if they do not move about the same axis.²³⁶ The reason is that the placement of points beneath the same points does not result because of motion over the same parallel [circles], but because of the co-rotation of the contained [(*scil.* innermost) sphere] in regard to the containing [(*scil.* middle) sphere] and its counter-rotation, since [this counter-rotation] removes as much as [the other] adds whether the rotation and counter-rotation are on an oblique circle or on a [circle] vertical [to the axis of the outermost sphere].²³⁷

[25] Again, given two homocentric spheres moving in the same direction, each one at a particular speed, and given that the smaller [sphere] not only moves with the greater but also performs its characteristic motion in the same direction, if the speeds are equal, the compounded motion will show²³⁸ a speed that is double; and if the speed of the second is double, the [speed] of the [motion] compounded will be triple; and likewise thereafter.

[501.1] For, if the larger [sphere] causes the smaller to move through a quadrant, and this [smaller one] being equally swift moves through a quadrant, it will have moved through twice a quadrant. Consequently, the [motion] arising from both [motions will be] double the second motion.²³⁹

We state these [conclusions about the compounding of two motions], [Sosi-
genes] says, if the motions should be about the same poles. But, if [they

²³⁵ 500.11 «διὰ» with accusative ('on account of'): see Moerbeke's 'propterea quod simul volvit tertiam' [Bossier 1975, 3.12.15–16]; and Grosseteste's 'et per simul vertere tertiam' [Bossier n.d.a, 182.20]. If «διὰ» is deleted [cf. Aujac et al. 1979, 172.12], the meaning is unchanged.

500.12 παραλλάττειν τὸ *A* (go to one or the other side of *A*).

²³⁶ 500.16–17: Simplicius now reports the case in which the outermost sphere has an axis of rotation that is different than the one shared by the inner two spheres.

²³⁷ 500.20 ἐπὶ ὀρθοῦ: circles are here defined in relation to their poles and axes; so a vertical circle, that is, any circle vertical to the axis of the sphere, is in other words a parallel circle. (It is called a parallel circle because the planes defined by such circles are parallel.) The circles in question here are presumably equatorial circles [cf. 152n209].

²³⁸ 500.25 δειξεί: Mueller [2005, 40] mistakenly supposes that the subject of this verb is 'Sosigenes'.

²³⁹ 501.1 τῆς ἐτέρας κινήσεως (the second motion): *scil.* the motion proper to the second sphere.

should] not [be] about the same poles, something else will result because of the obliquity of the second sphere. The reason is that the speeds will not be compounded in [the way just described], but as they have customarily been shown on a parallelogram when the motion on the diagonal is produced from two motions, one being [the motion] of some point as it moves on the length of the parallelogram and the other being [the motion] of this very length as it is drawn down through the width of the parallelogram in the same time interval.²⁴⁰ Certainly, the point and the side of the length²⁴¹ that is drawn down will be coincident at the other end of the diagonal; and the diagonal is not equal to [the sum of] both the [sides] deflected around it but smaller.²⁴² Consequently, the speed too is smaller than the speed arising from both together, though it is nevertheless compounded from both. [5] [10]

Now, that [result] too is stated alongside the following.

Given two spheres which are homocentric either around the same poles or around different [ones] but rotate in a direction opposite to one another, where the smaller [sphere] moves in the opposite direction at a lesser [speed] but is carried round at the same time by the larger [sphere], the points on the smaller [sphere] will arrive at the same point in a greater time interval than if the smaller sphere happened only to be fixed in the greater [sphere].²⁴³ [15]

Indeed, it is for this reason that the return from rising to rising of the Sun itself is slower than the rotation of the cosmos, that is, because it moves in the opposite direction to the universe [and] more slowly—since, if [the Sun] did indeed move at the same speed as the fixed sphere while rotating in the opposite direction, given that [the Sun] always made its return in the same time interval, it would be bound to rise always at the same point.²⁴⁴ [20]

²⁴⁰ 501.4–8: see Figure 12.09, p. 192. The underlying idea may be that the compounded motion of a body subject to motions imposed by two oblique rotating homocentric spheres may be projected onto the plane and treated as a compounded motion along the diagonal of a parallelogram.

²⁴¹ 501.9 ἡ τοῦ μήκους πλευρά: *scil.* the long side of the parallelogram.

²⁴² See Euclid, *Elem.* 1 dem. 20. See also [Aristotle] *Mech. prob.* 1 and Heron, *Mech.* 1.8 [Nix and Schmidt 1900, 18.28–22.3].

²⁴³ 501.12–17. This is true only if the two homocentric spheres share the same axis. If they do not, a point on the equator of the inner (slower) sphere will *not* in one revolution of the outer sphere return to the *same* point (on a suitable reference circle), though it will take longer to reach this circle.

²⁴⁴ 501.17–81: it is here imagined that there are but two homocentric spheres for the Sun [cf. 494.20–22 and Comment 12.14, pp. 264–265], presumably rotating in opposite directions about different axes, the outer sphere having the shorter period of rotation.

501.18–21: it is now overlooked that, if the spheres had the same period, the Sun would neither rise nor set but remain in one place.

501.21 τῷ αὐτῷ σημείῳ (at the same point): *scil.* on the horizon, a reference circle: cf. Aujac et al. 1979, 174. Note Mueller's 'with the same point' [2005, 40], presumably understanding 'on the celestial sphere', is possible, though the preceding sentence tends to favor the translation given above. In either case, the διότι-clause misfires.

Thus, with these things ascertained as presuppositions, Sosigenes, on coming to Aristotle's remarks about the need that, for each of the wandering [stars], there be other (unwinding) spheres fewer in number by one if
 [25] the phenomena are going to be accounted for, sets out the theory of the construction of spheres according to Aristotle when he says:

Now, the first of the spheres carrying Saturn was one that moves in accordance with the [sphere] of fixed [stars]; and the second was one that moves directly along the [circle] through the middle of the zodiacal [constellations].²⁴⁵ Third was the [sphere which moves] along the [circle] at right angles to the circle through the middle of the zodiacal [constellations], namely, the circle that
 [30] carried [Saturn] beyond [the zodiacal circle] in latitude from south to north. (This circle was at right angles to the [circle] through the middle [of the zodiacal constellations] because it had its poles on it—[circles] that intersect through the poles also intersect at right angles.)²⁴⁶ The fourth sphere (the one containing the [wandering] star) caused it to move over some oblique circle that delimits the latitude of its digression to the north so that it does not come to be near the poles of the cosmos.²⁴⁷

Accordingly, one must conceive of a different sphere, a fifth, before the four carrying Jupiter,²⁴⁸ which moves about the same poles as the fourth [of the spheres carrying Saturn] as it rotates in the opposite direction to it and in the same time interval. (The reason for this is that this [sphere] will subtract the motion of the fourth [sphere] because it moves about the same poles as it, yet in the opposite direction and at the same speed—this, after all, has been proven²⁴⁹—and it will decrease the speed [of Jupiter] in accordance with what is observed.)²⁵⁰

²⁴⁵ A sphere may be said to move along or over a circle if the sphere rotates about poles that are perpendicular to this circle.

²⁴⁶ 501.30–32: cf. Theodosius, *Sphaer.* dem. 11–15.

²⁴⁷ 501.32–502.2: cf. 496.23–497.2.

²⁴⁸ 502.2–3 δέῃ τοίνυν νοῆσαι πέμπτην σφαῖραν ἄλλην πρὸ τῶν φερουσῶν τὸν Διὰ τεττάρων: this reading, which has «τὸν Διὰ» instead of Heiberg's «τὴν διὰ», is evident in Grosseteste's 'oportet igitur intelligere quintam speram aliam ante ferentes Iovem quattuor' [see Bossier 1987, 296]. Mueller [2005, 109n165] emends Heiberg's «δεῖ τοίνυν νοῆσαι πέμπτην σφαῖραν ἄλλην πρὸ τῶν φερουσῶν τὴν διὰ τεττάρων» to «δεῖ τοίνυν νοῆσαι πέμπτην σφαῖραν ἄλλην πρὸ τῶν φερουσῶν τὸν Διὰ». But «τεττάρων» is well attested and appropriate.

502.3 πρὸ τῶν φερουσῶν: 'before' in the sense of 'between the fourth sphere (or Jupiter itself) and the observer on Earth'.

²⁴⁹ 502.5–6: cf. 499.17–500.21 along with Comment 12.25, pp. 278–283.

²⁵⁰ 502.7 κατὰ τὸ φαινόμενον: given the syntax, the point is that it will reduce Jupiter's speed so that it has the speed that it actually appears to have. Thus, both Grosseteste and Moerbeke have 'secundum apparentem velocitatem' [Bossier n.d.a, 184.24–25; Moerbeke [Bossier 1975, 3.15.12]: cf. Aujac et al. 1979, 175]. The claim is *not* that it reduces Jupiter's apparent speed, as Mueller has it [2005, 41 and n166].

After the fifth [sphere], one should conceive of another, a sixth, which has the same poles as the third but unwinds it by moving both in the same time interval and in the opposite direction so that the phenomena are saved, that is, so that points on the third [sphere] always appear at the same perpendicular on the fifth.²⁵¹ [10]

After this [sphere], one should add a seventh, the one that unwinds the second [sphere] in that it is fitted about the poles of the [circle] through the middle [of the zodiacal constellations] (poles about which this [second sphere] also rotates) yet rotates in the opposite direction and in the same time interval as the second [sphere]. That is, [the seventh sphere unwinds the second] in that it takes away from the motion and the speed that goes from it through to the spheres beneath it.²⁵² (For, in fact, the second [sphere], by moving with the fixed [sphere], contributed²⁵³ to the speed from east to west of the [spheres] beneath it.) Therefore, [the seventh sphere] will rotate by moving thus in the same way as the fixed [sphere]; yet it will not have the disposition of the fixed [sphere] in fact, since it rotates about different poles and not the [poles] of the fixed [sphere] but nevertheless from east to west.²⁵⁴ [15]

Finally, after this [seventh sphere], then, one should conceive of the first [sphere] of Jupiter as an eighth [sphere of Saturn], since Sosigenes has correctly established that the last of the three unwinding [spheres] is *not* the first of the [carrying spheres] of Jupiter. Some have thought this in fact, namely, that the last of the [spheres] unwinding the upper motions will be the first of the [spheres] carrying the [wandering] star below,²⁵⁵ so that the same sphere is seventh *and* the one that we say is eighth (which is the first of [20]

²⁵¹ 502.10–11 κατὰ τὴν αὐτὴν ἐπὶ τῆς πέμπτης κάθετον. This claim is problematic to say the least: see Comment 12.25, pp. 278–283. Nevertheless, so far as the perpendicular is concerned, it is to be dropped from a point on the carrying sphere in question to the plane of its equatorial circle and the thesis is that all points on the unwinding sphere in question will be fixed on on these perpendiculars.

²⁵² 502.14–15 ἀφαιρούσαν τὴν κίνησιν καὶ τὸ τάχος τὸ ἀπ' αὐτῆς διεικνούμενον εἰς τὰς ὑπ' αὐτὴν σφαίρας: the subject of the participle must be the seventh sphere and the referent in «ἀπ' αὐτῆς» and «ὑπ' αὐτὴν». See Comment 12.25, pp. 278–283.

²⁵³ 502.16 προσετίθει: 'contributed' rather than 'added' because, by moving from west to east, the second sphere actually diminishes the motion transmitted downwards by the first sphere. If a positive addition is meant, then Sosigenes/Simplicius [see 278n163] is assuming hypotheses at odds with *Meta.* 1073b24–27 [495.17–29]: cf. Aujac et al. 1979, 176n1. Mueller's proposed revision of the text [cf. 2005, 41] misses the mark: it [2005, 109n167] neglects the fact that, because the second sphere is carried round by the fixed sphere, it does indeed contribute to the east-west motion of the sphere below [cf. 494.20–22, 501.17–21].

²⁵⁴ 502.17–19: that is, in unwinding the second sphere, points on the seventh will be fixed in relation to the first sphere of the planetary system of spheres, and thus move from east to west as does the sphere of the fixed stars [see Comment 12.25, pp. 278–283]. But this is possible only because the seventh sphere itself rotates from east to west about the poles of the zodiacal circle in the same time interval as the second sphere.

²⁵⁵ 502.22–23. Points on the seventh sphere are fixed in relation to the first sphere of Saturn

- [25] the [carrying spheres] of Jupiter).²⁵⁶ Certainly, this follows for them because they are trying to count the same [sphere] twice in order to save the number of turning [spheres] mentioned by Aristotle.²⁵⁷

- Of course, it is necessary that the unwinding [spheres] for each star be fewer by one than the carrying [spheres]. Consequently, in the cases of Saturn and of Jupiter, since there are four carrying spheres for either,
- [30] the unwinding spheres are three in number, whereas in the cases of the
- [503.1] remaining four—Mars, Venus, Mercury, [and the] Sun—since there are five carrying [spheres] for each, [the unwinding spheres] are four in number [for each]. Thus, in all, the unwinding [spheres] of Saturn and Jupiter are twice three, and the unwinding [spheres] of Mars, Venus, Mercury, [and the] Sun are [altogether] four times four; so there are 22 in all. But the carrying spheres of Saturn and Jupiter were eight in number and 25 in number for
- [5] the remaining five [planets]. Thus, when these 33 [carrying spheres] have been added to the 22 unwinding [spheres], there are in all 55. (Of course, for the [spheres] carrying the Moon there is no need of unwinding [spheres] since it is last, given that Aristotle said also that ‘*only [the spheres] in which the [wandering] star stationed below moves need not be unwound.*’)²⁵⁸

and thus, since it therefore has the motion of the sphere of the fixed stars (albeit as a resultant motion), it will impose this motion on that sphere of Jupiter which has its poles fixed in it. Accordingly, this seventh sphere of Saturn *could* double as the first of the carrying spheres of Jupiter. Simplicius does not report Sosigenes’ argument that the first carrying sphere of Jupiter must be different from this seventh sphere (the third and innermost unwinding sphere) of Saturn. Cf. Comment 12.23, pp. 273–277.

²⁵⁶ 502.20–25; as Jonathan Beere [2003, 8] rightly notes, Simplicius thinks that this is wrong. Yet, rather than explaining why, Simplicius cites Sosigenes’ view [503.35–504.1] that it is better to hold that there has been a scribal error in the statement that there might be 47 spheres *in toto* than to try get this number by identifying the last unwinding sphere of the planet above with the first carrying sphere of the planet below. See 162n257.

²⁵⁷ 502.25–27: Aristotle [*Meta.* 1074a6–14] asserts that there are 55 spheres in all but also considers the possibility that there are only 47 spheres. This latter number caused commentators no end of trouble, as Simplicius makes clear. Note: if a sphere is counted twice, that is, if it is counted as a carrying sphere *and* as an unwinding sphere, the total number of spheres required is reduced. Thus, if one identifies the first carrying sphere of each planetary system with the unwinding sphere immediately above it, there will be 55 – 6 = 49 spheres in all.

²⁵⁸ 503.8–9 μόνας οὐ δεῖ ἀνελιχθῆναι ἐν αἷς φέρεται τὸ κάτω τεταγμένον ἄστρον. Simplicius’ quotation of *Meta.* 1074a8 makes poor sense. In point of fact, the Aristotelian mss have «μόνας οὐ δεῖ ἀνελιχθῆναι ἐν αἷς τὸ κατωτάτῳ τεταγμένον φέρεται» (‘only [the spheres] in which the [wandering star] stationed *farthest* below moves need not be unwound’) [cf., e.g., Ross 1953, ad loc.]. Mueller [2005, 43] tacitly assumes «κατατάτῳ» in Simplicius’ text. Grosseteste [Bossier n.d.a, 186.1] and Moerbeke [Bossier 1975, 3.17.2] have the comparatives ‘inferius’ and ‘subtus’, respectively.

503.9: on Simplicius’ reckoning of the 55 spheres, see [Alexander] *In meta.* 1074a8–9 [Hayduck 1891, 705.25–39].

Now, it is clear that this is the total number of all [the spheres]. But, when [10]
Aristotle inferred that ‘*if one does not add the motions which we mentioned
to the Sun and the Moon, there will be 47 [spheres] in all*,²⁵⁹ this caused
confusion. To explain: if we subtract the two [spheres] of the Sun and the
two [spheres] of the Moon which Callippus added and, clearly, two other [15]
[spheres] from the Sun as well —the ones that unwind these [two carrying
spheres for the Sun], given that, when those [carrying spheres] have been
subtracted, one must also subtract with them the spheres that are going
to unwind them—there will be six [spheres] that have been subtracted,
two which carry the Sun and the two which unwind these [spheres] in
addition to the two added for the Moon by Callippus. But it does not yet
result that, when these [spheres] have been subtracted from the 55, there
are 47 [spheres] left in all; rather, there will be 49. But Aristotle says that 47 [20]
are left behind, either as though he had forgotten that he removed not four
[spheres] from the Moon but only two—unless one should say, therefore,
that he subtracted the four unwinding [spheres] from the Sun which he
himself added and from both [the Sun and Moon] the [spheres] which
Callippus [added]; and, thus, [that], since there are eight spheres that have
been subtracted from the 55, the remaining [spheres] are 47 in number. [25]
This is how the number results. Yet why there are not some [spheres] to
unwind the two spheres of the Sun (the second and the third) we cannot
say, given in fact that he says only this, that *the [wandering star] lying below
is not unwound*.²⁶⁰ And yet Sosigenes has also established correctly that one
must hypothesize the unwinding [spheres of the Sun] for the Moon, lest [30]
the speed of the upper motions when added to the spheres carrying [the
Moon] no longer make it advance to the west at the same speed as the fixed

²⁵⁹ 503.10–26: cf. [Alexander] *In meta.* 1074a12–14 [Hayduck 1891, 705.39–706.13].

503.11–12 εἴ τις μὴ προσθῇ τῷ ἡλίῳ καὶ τῇ σελήνῃ ἃς εἵπομεν κινήσεις, ἑπτὰ καὶ τεσσαράκοντα ἔσονται πάσαι. At *Meta.* 1074a12–14, modern editors have «εἰ δὲ τῇ σελήνῃ καὶ τῷ ἡλίῳ μὴ προστιθῇ τις ἃς εἵπομεν κινήσεις, ἑπτὰ τε καὶ τεσσαράκοντα» [cf., e.g. Ross 1953, ad loc.]. See Comment 12.23, pp. 273–277.

²⁶⁰ 503.26–27: Moerbeke has

propter quid autem a sole duas, secundam scilicet et tertia, auferri, si non sustinent aliqui, non habebimus dicere

But, if some do not keep [them], we will not be able to say why two [spheres], namely, the second and the third, are taken from the Sun, [Bossier 1975, 3.17.17–19]

which is more a paraphrase than a translation [cf. Bossier n.d.a, 186.19–20].

503.26–27 διὰ τί ... οὐκ ἀνελίσσουσιν τινες: lit. ‘why some [spheres] will not unwind the two spheres ...’.

503.27–28 ταῦτα εἰπόντος ... μὴ ἀνελίσσεσθαι: a paraphrase of *Meta.* 1074a7–8.

[sphere]. But, thus, even when it is granted that the [Moon] alone does not have an unwinding [sphere], the number does not follow; and this disturbed Alexander and Porphyry in their lectures on [book] Λ of the *Metaphysics*.²⁶¹

- [35] Sosigenes, who understands [the problem], says that it is better to think
[504.1] that there has been an error in the number by scribes than to make the seventh and eighth spheres the same.²⁶² (Not even if this were the case, would the number be consonant with the text, given that there will still not be 55 [spheres] in all, just as [Aristotle] himself says.)

Sosigenes also adds the following when he says that

- [5] it is clear from what has been said that Aristotle calls [the spheres] unwinding in one sense whereas Theophrastus calls them compensating in another.²⁶³ Indeed, both [designations] apply to them. That is to say, [these spheres] unwind the upper motions and compensate²⁶⁴ the poles of the spheres beneath [the wandering stars]²⁶⁵ by removing the former [motions] and bringing the latter to what is required.

- The reason is that the motions from above should not extend to the diverse
[10] [motions] of the stars lower down and that the poles of the [spheres] below should fall beneath the same perpendicular as the poles of similar spheres,²⁶⁶ so that the first spheres of the [wandering] stars stationed beneath (and, clearly, because of them, the spheres after them as well) can be restored to the same position, just as he says. ‘Certainly, in this way alone’, he rightly
[15] says, ‘is it possible for all [the wandering stars] to make the motion of the fixed [stars],’ as we have already said.²⁶⁷

²⁶¹ 503.28–504.3: see fr. 160a in Rescigno 2004–2008, 2.301–312. Rescigno’s fr. 160b = [Alexander] *In meta. 1073b17* [Hayduck 1891, 702.38–706.15].

503.34: Porphyry (AD 234–ca 305), a student of the philosopher Plotinus (205–270), was very productive in his own right and left his mark on later Platonism [see Smith 1996; O’Meara 1989, 25–29].

503.34 τῆς Μεταφυσικῆς: F has «Μετὰ τὰ φυσικά», the reading of A at, e.g., 422.17, 497.9, and 505.27.

²⁶² 503.35–504.1: cf. [Alexander] *In meta. 1074a12–14* [Hayduck 1891, 706.13–15].

503.35–504.1: Sosigenes apparently held that the number should have been 49.

²⁶³ 504.4–15 = Theophrastus fr. 165D in Fortenbaugh et al. 1992. See 493.17–20 and 146n175. For discussion, see Bodnár 2005, 271n25 and 273.

²⁶⁴ 504.7 ἀντανάφερουσι (compensate): lit. ‘bring back(wards) in (re)turn’. Theophrastus’ «ἀντανάφερούσας» is the present participle of this verb: see 146n175.

²⁶⁵ 504.8 ὑπ’ αὐτούς: *scil.* lit. ‘beneath them’, where ‘they’ (masc. pl.) cannot be the spheres (fem. pl.). This reference to items syntactically outside Simplicius’ own text signals that he is quoting Sosigenes.

²⁶⁶ 504.10–11 ὑπὸ τὴν αὐτὴν κάθετον (beneath the same perpendicular): *scil.* a perpendicular drawn from the sphere’s pole to its equatorial plane. In other words, the spheres should have the same axis.

²⁶⁷ 504.9–15: Mueller [2005, 43 and n177] includes these lines in the citation of Sosigenes.

The spherical construction by means of unwinding spheres is somewhat like this. [It is a construction] which cannot save the phenomena, as Sosigenes also remarks critically when he says:

Nevertheless, the [spheres] of the Eudoxans do not in fact save the phenomena, not as they have been ascertained later nor even as they had been recognized before and accepted by those same people.²⁶⁸

[20]

And why should we speak about the rest [of the phenomena], some of which even Callippus of Cyzicus tried to save when Eudoxus was not successful, if indeed [Callippus] did save [them]? But, at least this one itself, which is indeed manifest to the eye, none of them before Autolycus of Pitane in fact tried to demonstrate by means of hypotheses, although not even Autolycus himself was successful—his dispute with Aristotherus²⁶⁹ reveals [this]. What I mean is that the [planets] sometimes make their appearance nearby and sometimes after they have receded from us.²⁷⁰

[25]

This is indeed obvious to the eye in some cases. That is, the star said to belong to Venus and, moreover, the [star belonging to] Mars appear many times greater at the middle of their retrogradations,²⁷¹ with the result that, on moonless nights, the [star] of Venus for its part causes shadows to fall from bodies.²⁷²

[30]

Furthermore, even in our unaided sight,²⁷³ the Moon obviously does not always stand the same [distance] from us because it does not always appear

But, as «καθάπερ φησίν» at 504.12 indicates, in 504.9–14, Simplicius is speaking *propria voce*. 504.14–15 is another citation.

²⁶⁸ 504.17–505.25: Aujac et al. [1979, 179–181] follow Heiberg in supposing that the citation of Sosigenes extends from 504.17 to 505.27, but there is reason to doubt that this is correct. Proclus, *Hyp. ast.* 4.98 [see p. 249, for translation] does, I admit, indicate that Sosigenes' account of the turning (or unwinding) spheres did include mention of solar eclipses. Moreover, 505.1–11 is consistent with Proclus' report. The problem is that such consistency is not a sufficient basis for ascribing all of 504.17–505.27 to Sosigenes, especially in light of the fact that this passage introduces argument on other subjects as well, and that its syntax does not require such an attribution. Note also that 504.20–22 seems more likely to come from Simplicius, given 497.22–24: cf. 154n213.

504.18 τῶν περὶ Εὐδόξου: on the locution, see Comment 10.07, pp. 206–207.

²⁶⁹ 504.24–25: on Aristotherus, see Comment 12.26, pp. 283–284.

504.28: on Autolycus' dates, see Bowen and Goldstein 1991, 246nn29–30.

²⁷⁰ 505.25–25: Simplicius has touched on this issue earlier [32.12–33.16] in a different but related context. See Comment 12.27, pp. 284–288.

²⁷¹ 504.28 προηγῆσαι. See Comment 12.28, pp. 288–289.

²⁷² 504.29–30: see Comment 12.29, pp. 289–290.

²⁷³ 504.30 ἐν αὐτῇ μὲν τῇ ὀψει: lit. 'in sight (by) itself'. Simplicius is about to distinguish naked eye observation and observation with instruments, so «αὐτῇ» is important. But see Mueller 2005, 43.

to us to have the same size, though the same conditions obtain with reference to the [medium] through which it is observed.²⁷⁴ Nevertheless, [should the Moon *not* appear so to our unaided sight,]²⁷⁵ the same thing seems true to us also if we make observations more instrumentally, because sometimes
 [35] a drum of 11 digits²⁷⁶ and sometimes a drum of 12 digits blocks the observer's sight so that it does not fall upon [the Moon], though [the drum] is set at the same distance from him.²⁷⁷

[505.1] In addition to these [instrumental observations], the events at total eclipses of the Sun also testify to what has been said [about the Moon], and are in fact proofs of its truth. That is to say, when the center of [the Sun], the center of the Moon, and, moreover, our eye happen to be in a straight
 [5] line, the results do not always appear the same. Instead, the Sun in fact is itself sometimes completely enclosed by the cone which encloses the Moon and has our eye as its vertex (that is, sometimes in fact [the Sun] spends

²⁷⁴ 504.32 τῶν αὐτῶν περὶ τὸ δι' οὗ θεωρεῖται καθεστῶτων: lit. 'the same things obtain concerning that through which it is observed'. Cf. 505.9–11. Mueller [2005, 44] misses this clear reference to the medium. On the general claim about the Moon, see Comment 12.30, pp. 290–291.

²⁷⁵ 504.33 οὐ μὴν ἀλλὰ καὶ [cf. 1.24–2.5, 431.30–32]. This collocation of particles answers to «μέν» in 504.30 [cf. Denniston 1966, 30; Blomqvist 1969, 57–58], and announces the strongest case for the thesis that the Moon varies in distance to the Earth. The connection with the preceding sentence may be spelled out by 'But, *if* it is not obvious to the naked eye that the Moon varies in size and, hence, in distance, nevertheless ...' Heath's translation [1913, 222] does not save the contrast between naked eye and instrumental observation at issue here, a contrast that is also indicated by the comparative adverb «ὀργανικώτερον» ('more by means of instruments') in 504.33. Cf., e.g., Theon, *De util. math.* 3.22 [Hiller 1878, 150.7–12 and T.H. Martin 1849, 213].

504.33: see Comment 12.31, p. 291.

²⁷⁶ 504.33 ὀργανικώτερον. The instrument that Simplicius alludes to seems to be the Hipparchan dioptra first mentioned by Ptolemy in *Alm.* 5.14 [Heiberg 1898–1907, 1.417.1–3: cf. Proclus, *Hyp. ast.* 4.71–72]. One form of this instrument was subsequently described by Pappus [*In Ptol. syn. ad 5.14*: Rome 1931–1943, 1.90–93] and another, by Proclus [*Hyp. ast.* 4.87–96: cf. 4.72]: cf. Price 1957, 591. Though Simplicius does not describe the instrument in any detail, the fact that he says nothing of any holes in the movable drums suggests that he may have in mind Pappus' rather than Proclus' version. Simplicius' main departure from all previous extant accounts of this device lies in his speaking of drums (τύμπανα) rather than small prisms (πρισμάτια).

504.34 ἐνδεκαδάκτυλον. See Comment 12.32, pp. 291–292.

²⁷⁷ 504.34–505.1: according to Levi ben Gerson [Goldstein 1985, 102 sentence [10]], the apparent size of the Moon only varies a little between quadrature and opposition. Indeed, Bernard Goldstein informs me that in chapter 75 (unpublished) of his *Astronomy*, Levi asserts that he could detect no variation in the Moon's apparent size between 0° and 180° of anomaly, that is, he could find no measurable difference between the apparent sizes of the Moon no matter what the argument of anomaly was. In modern times, the apparent size of the Moon has been found to vary from 0;29,20° to 0;33,32° [cf. Aujac et al. 1979, 180m].

some time interval without being visible to us); and sometimes, again, [the configuration] is so far [removed] from this that at the mid time interval of the eclipse, some rim of [the Sun] is in fact left shining round from outside [the cone].²⁷⁸ Consequently, it must be necessary that the difference [10] in the sizes [of total solar eclipses] be evident because of the inequality of the [Moon's] distances, though the atmospheric [conditions] are about the same.²⁷⁹

But, in that what happens in these instances [just described] is plain in fact to sight, it is reasonable that [the same] happens in the others as well even if it is *not* manifest to sight. Indeed, not only is it reasonable, it is in fact true, since the daily motion of the [other planets] appears unsmooth.²⁸⁰ But, concerning their apparent sizes, no difference is noticed because their [15] variation in altitude and its opposite (which scientists used also to call motion in depth) is negligible.²⁸¹ Thus, they did not try at all to save this [phenomenon] and, consequently, they did not indicate the changing daily [motion of the planets], although [Plato's] question requires this.

But yet, it is not admissible to say that the inequality of the distances of each [planet] in relation to itself really escaped their notice. For, evidently, [20] Polemarchus of Cyzicus recognizes it but dismisses it as not being perceptible, because he prefers more the positioning of the spheres themselves in the universe about its very center.²⁸²

And even Aristotle in his *Problemata physica* clearly sets forth further problems for the astronomers' hypotheses, [deriving] from the fact that [25] the sizes of the planets do not appear to be the same.²⁸³ Thus, he was not

²⁷⁸ 505.3–9: the point of this argument is, again, that the Moon varies in distance to the Earth [cf. 505.1–3]. There is no need to follow Schiaparelli in inferring that this argument also entails awareness of, or supposes, a variation in the apparent diameter of the Sun: cf. Heath 1913, 223–224.

²⁷⁹ 505.9–11: these lines concern the Moon and conclude the argument that began in 504.30; they are not a remark about the planets in general (as Mueller [2005, 44] supposes).

²⁸⁰ 505.11–17: on this claim about the motions of planets other than the Moon, see Comment 12.33, pp. 292–293.

²⁸¹ 505.15 οὐ προσπίπτει τις διαφορά: lit. 'it is not the case that any difference befalls [sight]'.
²⁸² 505.16 κατὰ βάθος: the earliest occurrence of the usage that Simplicius alludes to seems to be in the Keskintos Inscription (ca –100), though its significance there is admittedly not well understood [cf. Neugebauer 1975, 698–705; Jones 2006]. Cf. Pliny, *Nat. hist.* 2.68; Plutarch, *De facie* 937f, 939a–b.

505.17 οἱ ἀπὸ τῶν μαθημάτων: cf. 150n196.

²⁸² 505.21–23: see Comment 12.34, pp. 293–294.

²⁸³ 505.24 τοῖς Φυσικοῖς προβλήμασι. The *Physica problemata* (= *Quaestiones physicae*) that has come down under Aristotle's name is a compilation of texts written in the Peripatetic school made perhaps as late as the fifth and sixth centuries AD, though there is modest reason

[30] completely satisfied with his turning [spheres], even if [the thesis] that they are homocentric with the universe and move about its center won him over.²⁸⁴ And, further, from what he says in *Metaphysics* Λ, he is evidently not one who thinks that the [features] of the motions of the wandering [stars] have been stated adequately by the astronomers up to and during his time. At any rate, he says [this] in the following:²⁸⁵

[506.1] *Thus, to give [some] conception [of the problem], we now state what some of the mathematical scientists²⁸⁶ say, that is, in order that there be some definite number for thought to grasp. But, as for the rest, as we investigate some things ourselves and learn other things from those who conduct investigations, if anything is revealed to [us] in engaging with these matters in conflict with what has been stated now, we must treat both [accounts] kindly but believe the more accurate.²⁸⁷*

But, also in the same book, after he has enumerated all the motions together, he remarks:

to think it may include sections of a book of the same name written by Aristotle himself [cf. Louis 1991–1994, 1.xi–xxxv]. Precisely which sections these may be is a matter of scholarly concern that lacks a credible means of resolution. In any case, I will put this issue aside for now, since no problem in the treatise as it has come down to us raises any difficulties involved in positing fixed planetary distances. The only one that even remotely seems to suggest the possibility of variable planetary distance is *Prob.* 15.4, but it does this counterfactually. So, if this were the text that Simplicius is alluding to, he has certainly read it against the grain in order to support his story.

Aujac et al. [1979, 181n2] think that the passage which Simplicius has in mind was a false report inserted into a version of the *Problemata* now lost and intended to excuse Aristotle from his adherence to homocentric theory.

505.24–25 ταῖς τῶν ἀστρολόγων ὑποθέσσειν.

²⁸⁴ 505.26 ταῖς ἀνελιττούσαις: cf. 135n13.

505.27 ἐπιγγάγετο αὐτόν: though there is a Greek ms. with «αὐτῷ», «αὐτόν» seems correct: cf. Grosseteste's *induxit ipsum* [Bossier n.d.a, 189.17] and Moerbeke's 'placuit sibi' [1563, 177.col.A].

²⁸⁵ 505.29 ἀστρολόγων.

505.30 λέγει γοῦν ὦδέ πως. There is no uncertainty here: the quotation makes Simplicius' point. See Comment 12.19, pp. 269–271.

²⁸⁶ 505.31 τῶν μαθηματικῶν.

²⁸⁷ 505.30–506.3: *Meta.* 1073b11–17. Simplicius omits a clause [*Meta.* 1073b10–11] immediately before the lines that he quotes. This is why he writes «νῦν μὲν οὖν ἡμεῖς» where the received text has only «νῦν μὲν ἡμεῖς». Heiberg's text also has «ὑπολαμβάνειν, τῶν ζητούντων» and «ἐάν» instead of «ὑπολαβεῖν, παρὰ τῶν ζητούντων» and «ἄν», respectively [cf. Ross 1953, ad loc.].

Heath [1913, 223] rightly follows Schiaparelli in rejecting Simplicius' imputing to Aristotle doubts about homocentric theory in this passage as an attempt to excuse later Peripatetics from abandoning homocentric spheres in favor of epicyclic and eccentric spheres [cf. 506.8–16]. Indeed, the uncertainty registered here is limited to the count of carrying and unwinding spheres.

506.2 παρὰ τὰ νῦν εἰρημένα τοῖς ταῦτα πραγματευομένοις. See Comment 12.35, p. 294.

*Let the number of the motions be this great, so that it is reasonable to suppose that the substances, that is, the unmoved and perceptible first principles, are as numerous. Let what is actually necessary be left for the more vigorous to say.*²⁸⁸ [5]

His ‘let ... be’, ‘reasonable’, and ‘leave for others more vigorous’,²⁸⁹ show his uncertainty about them.

Thus, while we give credence to Aristotle, we must follow more those who come later, on the grounds that they save the phenomena more [effectively] even if they do not save them completely,²⁹⁰ since neither did [the homocentrists] know so many phenomena—on account of the fact that the observations sent by Callisthenes²⁹¹ from Babylon, when Aristotle required this of him, had not yet arrived in Greece (Porphyry reports that these [observations] were preserved for 31,000 years up to the times of Alexander of Macedonia)²⁹²—nor were they able to demonstrate by means of their hypotheses all [the phenomena] which they did know. [10]

Ptolemy too criticizes them²⁹³ on the grounds that they introduce a great multitude of spheres for the sake of the joint return of the seven planets in relation to the rotation of the fixed [sphere] alone, as well as for saying that [the spheres] contained by the containing [spheres], that is, the innermost [spheres],²⁹⁴ are causes of the joint return for the [spheres] above them, although nature always makes higher things causes of motion for things that [20]

²⁸⁸ 506.4–7: *Meta.* 1074a14–17. Modern editions of Aristotle’s text have «τὸ μὲν οὖν πλήθος» (Simplicius omits «οὖν»); moreover, they follow [Alexander] [Hayduck 1891, 706.16–17, 23–24] and athetize Simplicius’ «καὶ τὰς αἰσθητάς» (‘and perceptible’) [cf. Ross 1953, ad loc.], though these words do appear in all the mss of the *Meta*.

²⁸⁹ 506.7–8: Simplicius recalls text that he has just quoted [506.6–7]. Note that his «ἄλλοις ἰσχυροτέροις» (‘for others more vigorous’) departs from the original. Grosseteste [Bossier n.d.a, 190.1–4] has:

necessarium enim dimittatur fortioribus dicere. Et hoc igitur sit et rationabile et aliud fortioribus relinquere, quod circa ipsa dubium ostenditur.

²⁹⁰ 506.10 καὶ εἰ μὴδὲ οὗτοι τελέως διασώζουσιν: Simplicius thus hints at some technical criticism of the non-homocentric hypotheses.

²⁹¹ 506.11–12: Callisthenes was Aristotle’s nephew and a historian who traveled to Babylon in Alexander’s entourage [see Bosworth 1966].

²⁹² 506.13–15: see Comment 12.36, p. 295.

²⁹³ 506.16: see Comment 12.37, p. 296.

506.16 αὐτοῖς: *scil.* those who adopt homocentric hypotheses.

506.16–22: Simplicius now summarizes criticisms that Ptolemy makes in book 2 of his *Hypoth. plan.*, a text that survives only in Arabic [cf. Nix 1907, 118.20–31] and in a Hebrew translation of the Arabic. See Comment 12.25, pp. 278–283.

²⁹⁴ 506.18–19 τὰς περιεχόμενας ταῖς περιχοῦσαις καὶ ἐσχατάς: Mueller [2005, 44] has ‘contained and last spheres’, thus missing the instrumental dative and the epexegetis.

are lower. Certainly, even in human beings, it is from on high, that is, from our ruling part, that the impulses for motion are distributed through the nerves to all our organs.²⁹⁵

- And I do not understand *why* they ever set the first sphere for each [wandering] star as moving similarly and at the same speed as the fixed [sphere], and as making all the spheres after it down to the [sphere] that has the [wandering] star return jointly with the fixed [sphere].²⁹⁶ To explain: if the [sphere] above passes on to the [spheres] below the form of its proper motion, why do we not say that the fixed [sphere], which is the most powerful and strongest sphere of all, causes all the spheres beneath it to return jointly to the same position by itself? Of course, it was necessary that the [spheres] performing the motion in longitude and in latitude be different, since these were different [motions] for each [wandering] star. [25] But how did the joint return with the fixed [sphere] (which is the same for all the spheres) not be satisfied by the rotation of the fixed [sphere]? How instead did it, according to Aristotle, need [spheres] performing this motion for each [wandering] star as well as for spheres unwinding those ones?²⁹⁷ They might perhaps say²⁹⁸ that, even if [the spheres] return jointly [30] with the fixed [sphere] by performing the same motion westwards as it, since they are instead different in size, they are also utterly different in speed of motion.²⁹⁹ How, then, was it reasonable that [spheres] which are set free (that is, not bound together) perform different motions at the agency of a single [sphere], the fixed [sphere]?³⁰⁰ [507.1]

²⁹⁵ 506.22 τοῦ ἡγεμονούντος μορίου: *scil.* from our controlling part or command center.

506.22 διὰ τῶν νευρῶν: see Comment 12.38, pp. 296–297.

²⁹⁶ 506.23–25: Mueller [2005, 45] overlooks that «κινουμένην» and «συναποκαθιστῶσαν» are participles modifying «τὴν πρώτην σφαῖραν».

²⁹⁷ 507.2 ἡρξέσθῃ ... ἐδέχθῃ: Mueller [2005, 46] incorrectly supposes that the subject of these verbs is Aristotle.

507.3 ἐκεῖνας (those ones): *scil.* the spheres producing motion in longitude and latitude. As Taïeb Farhat has emphasized in correcting an earlier version of my translation, these spheres must be unwound if the diurnal motion of the planet beneath is to be preserved.

²⁹⁸ 507.4 λέγοιεν δὲ ἄν ἴσως: the verb is plural not singular as Mueller [2005, 46] supposes.

507.4–10: this is not a particularly compelling suggestion, trading as it does on a difference in linear speed even when angular speed is the same. Simplicius is trying to make the case for an argument that does not really seem to convince him.

²⁹⁹ 507.5–7. The angular speed of the spheres is the same: it is the linear speed that varies with the radius.

³⁰⁰ 507.7–8. If there must be a sphere for the fixed stars, how can this sphere be responsible for such a diversity among the (linear) motions of the first carrying spheres, when these spheres are unconnected and thus unlike homocentric circles drawn on a solid, rotating wheel?

In giving judgment against the hypothesis of turning [spheres] especially because it does not preserve the difference in depth (that is, the anomaly)³⁰¹ of the [planetary] motions, those who came later rejected the homocentric turning [spheres] and hypothesized eccentric and epicyclic ones—unless the hypothesis of eccentric circles was conceived by the Pythagoreans,³⁰² as Nicomachus and some others say as well as Iamblichus (who follows Nicomachus).³⁰³ But, in order that we get some conception of the use of these hypotheses in producing a comprehensive study of the heavens,³⁰⁴ let the eccentric hypothesis be set out first in comparison with the homocentric [hypothesis] in a diagram. [10]

Let the circle through the middle of the zodiacal [constellations], *ABCD*, be conceived of as homocentric about the center *E* (at which let it be supposed our eye is) and the [line] *AEC* as a diameter.³⁰⁵ Then, if the [wandering] star makes smooth progress from *A* to *B* on the circle *ABCD*, it is evident that, since our eye happens to be at the center *E*, if we conceive of the ray that falls from [our eye] to the [wandering] star as the straight [line] *AE*, this [line] too will be brought around smoothly with it. And, of course, the [wandering] star will be plainly evident both making its progress smoothly and keeping away from us at a distance that is always the same. [20]

But, since [the planets] are not observed in this way but as always making their progress unsmoothly and standing apart [from us] at different distances at different times (as is clear from the difference in their sizes),³⁰⁶ let the circle *ABCD* no longer be supposed as homocentric to the zodiacal [circle] so that, for example, the center of the zodiacal [circle] (on which we say our eye is) no longer happens to be at *E* but at *F*.³⁰⁷ That is, [let it be [25]

³⁰¹ 507.10 τὴν ἀνωμαλίαν. This is first use of «ἀνωμαλία» in its technical sense to signify the mean motion of a planet on its epicycle: see Evans 1998, 337 for the terminology in the case of a simple epicyclic model [cf. Toomer 1984, 21]. (Epicyclic) anomaly, which is measured from the apogee of the epicycle, incidentally accounts for what was known as motion 'in depth'. Cf. 135n112.

³⁰² 507.13 ὑπὸ τῶν Πυθαγορείων: see Comment 12.39, pp. 297–298.

³⁰³ 507.13 Νικόμαχος ... Ἰάμβλιχος: Nicomachus of Gerasa was a Pythagorean who was active ca 100 [cf. Tarán 1974; O'Meara 1989, 14–23]. Iamblichus of Chalcis (ca 245 to ca 325) was a Platonist philosopher who may have studied with Porphyry [cf. O'Meara 1989, 30n1].

507.13–14 ἄλλοι τέ τινες ... καὶ ... καὶ. On the locution, see 244n56.

³⁰⁴ 507.14–16: cf. 492.28–31.

507.15 τὴν πραγματείαν (comprehensive study).

³⁰⁵ 507.18–19: see Figures 12.10(a)–(b), p. 193.

³⁰⁶ 507.25–27: a claim that presents as a matter of plain observation what is in truth a blend of fact, falsehood, and inference [see 504.16–505.19].

³⁰⁷ 507.27–29: Mueller [2005, 47 and n210] gets into difficulty because he does not see that «τὸ τοῦ ζῳδιακοῦ κέντρον» is the subject of the subordinate clause «ἵνα ... τυγχάνῃ ...».

supposed] that the [circle] *ABCD* is no longer homocentric to the circle through the middle of the zodiacal [constellations] but eccentric to it, and that *A* is the farthest [point] of it from the Earth (this is the [point] which is at the greatest distance from our eye at *F*) while *C* is the [point] nearest the Earth (the [point] which is at the least distance from our eye at *F*).

[35] Then, if we conceive of the [wandering] star in the same way as traveling
[508.1] the arc *AB* smoothly from apogee *A* to *B* on the eccentric circle *ABCD* and of some straight [line] from the center [*E*]³⁰⁸ as being brought around with it, this [line] too will be brought around smoothly. Then, let it be the [line] *EB*.

Then, the result will be that, when the [line] *FB* is joined from our eye at *F* to the [wandering] star, the [wandering] star has traveled the angle *AEB* smoothly but that it has *appeared* [to travel] a smaller [angle], *AFB*. To explain: since the angle at *E* is an exterior angle of the triangle *BEF*, it is greater than the interior and opposite angle at *F*.³⁰⁹

[5] But, if [the planet] in making its progress from the perigee *C* travels the arc *CD* smoothly (so that the straight [line] *ED* is also brought around smoothly with it), and if we join in turn the straight [line] *FD* from our eye at *F*, the smooth progress from the perigee will be contained by the
[10] angle *CED* and the unsmooth or apparent [progress] by the angle *CFD*. And the apparent [progress] along the [arc] from the perigee *C*³¹⁰ will clearly be farther than the smooth [progress], because the angle at *F* is greater than the [angle] at *E*.

That is, in the case of the [wandering] star's position at *B*, angle *AEB* will be smooth, while angle *AFB* will be apparent and angle *EBF*, the difference.³¹¹

[15] But, in the case of the star's position at *D*, angle *CED* will be smooth, while angle *CFD* will be apparent and angle *EDF*, the difference.

Now, though this [eccentric] hypothesis fits the stated goal of the mathematical scientist³¹² in respect of greater simplicity, they³¹³ also sought out another which could demonstrate the same things as the aforementioned

[20] [hypothesis], that is, the result that, though the [wandering] stars move

³⁰⁸ 507.35–508.1 ἀπὸ τοῦ ἐκκέντρου: as Grosseteste's translation indicates, the text should read «ἀπὸ τοῦ Ε κέντρου» [cf. Bossier 1987, 297].

³⁰⁹ 508.4–6: *scil.* $\angle AEB > \angle EFB$. Cf. Euclid, *Elem.* 1 dem. 16.

³¹⁰ 508.12: reading «Γ» rather than «Ζ»: cf. Aujac et al. 1979, 186. Mueller [2005, 47 and n213] chooses instead to athetize «περιγείου». Grosseteste [Bossier n.d.a, 192.25] has only 'a proximo terrae'.

³¹¹ 508.13–15: cf. Euclid, *Elem.* 1 dem. 32 with dem. 13.

³¹² 508.17 τῷ εἰρημένῳ σκοπῷ τοῦ μαθηματικοῦ: cf. 174n319.

³¹³ 508.18 ἐξεύρον: cf. 507.9 οἱ μεταγενέστεροι.

smoothly, they appear to traverse arcs of the circle through the middle of the zodiacal [constellations] unsmoothly.³¹⁴

That is to say, once more let the circle *ABCD* be conceived of as homocentric with the [circle]³¹⁵ through the middle [of the zodiacal constellations] about a center *E* where again our eye is. And let the [wandering] star be conceived of not as making its motion on [*ABCD*] but along *FGHJ*, a small circle (called an epicycle) which always has its center *A* on the circumference of the circle *ABCD*, so that the star is likewise farthest from the Earth at *F* and nearest at *H*.³¹⁶

[25]

It is also clear, when the epicycle has smoothly traveled the arc *AB* and is at *B* (the [straight line] *EB* being brought round with it smoothly in turn too), when the star by making its progress from the apogee *F* to *G* has traveled the [arc] *FG* smoothly in turn, and when we join the straight [line] *EG* from our eye at *E*, that the star will in turn have been brought smoothly round the arc *AB* (that is, the angle *AEB*) by the epicycle, that [the star] is evidently [brought round] the [angle] *AEG* which is greater than the smooth [angle, *AEB*], and that the angle *BEG* is the difference of [the angles].

[30]

[509.1]

But, when the [planet] makes its progress from the apogee *F* not to *G* but to *J*, the angle *AEB* will once more belong to the smooth progress and the [angle] *AEJ* to the apparent [progress], which is smaller than the smooth one, and [angle] *JEB* will be their difference.

[5]

Consequently, this sort of hypothesis can demonstrate the progress of the [wandering] stars at [positions] nearer the apogee as both greater and smaller—clearly greater when the star makes its progress from the epicycle's apogee in the same direction as the [deferent] circle, and smaller when [the star makes its progress] in the opposite direction.³¹⁷ (The eccentric [hypothesis] always [makes] the apparent [passage] at a point nearer the apogee smaller than the smooth [progress], since the apparent [angle] *AFB* is in fact always smaller than the smooth [angle] *AEB*.)³¹⁸

[10]

³¹⁴ 508.18–21: cf. Comment 12.39, pp. 297–298. Note that at this point in this story, the mathematical equivalence of the epicyclic and eccentric hypotheses is unknown: cf. Bowen 2007, 339n40.

³¹⁵ 508.22 Reading «τῷ» with F instead of «πρὸς τὸ» with A: cf. 493.10, 491.11, 507.30, 510.5; Aujac et al. 1979, 186. Grosseteste [Bossier n.d.a, 193.7–8] has 'concentricus ei qui ...'.

³¹⁶ 508.22–27: see Figure 12.11, p. 194.

³¹⁷ 509.8–10 μείζονας μὲν δηλονότι ... ἐπὶ τὰ ἐναντία: *scil.* when the planet has moved less than 180° or more than 180° on its epicycle.

³¹⁸ 509.10–12: see Figure 12.12, p. 195. According to Simplicius [36.22–24: cf. 32.1–11], Philoponus adopted the epicyclic hypothesis:

And as the [deferent] sphere of Mercury rotates, he [*scil.* Philoponus] says, the star, by

[15] Either one of these hypotheses will afford the astronomer's goal³¹⁹ when taken by itself, except that in the case of the Moon they need both [hypotheses] compounded. That is to say, they hypothesize that the epicycle carrying the Moon is brought round on an eccentric circle in order that the phenomena be saved by it.³²⁰

These hypotheses are in fact simpler than the earlier ones in that they do not require fabricating so many heavenly bodies, and they save the rest of the phenomena and especially the ones concerning depth or anomaly.

[20] But they do not maintain Aristotle's axiom, the one that wants every body moving in a circle to move about the center of the universe. Further, not even the stated solution of [Aristotle's second] problem, [a problem] because of which all these arguments were raised, has in the end any standing.³²¹ That is, it is not the case that equalization still has any standing, since what was said is no longer true, namely, that the first motion, though one in number, causes many divine bodies to move; whereas the [motions] which are many
[25] in number each [cause] only one [body to move]. The reason is that the [motions] before the last (that is, the one that has one star) do not move many bodies.³²²

Sosigenes brought these absurdities as well against these hypotheses, though he was not satisfied by the [hypothesis] of turning [spheres] for the reasons stated before.

[30] But those who think that the [wandering] stars have their characteristic motion because they are in fact ensouled must object to the first [of Aristotle's axioms]: for [the planets] are not only parts of the heavens, each is also a whole by itself. Thus, a truer axiom would be the one stating that every body which moves in a circle moves about its *own* center.³²³

moving on its characteristic epicycle, is sometimes nearer the Earth and sometimes farther from it; and the same holds for the remaining wandering [stars].

[= Wildberg 1987, fr. 15: cf. fr. 7]

³¹⁹ 509.13 τὸν ἀστρονομικὸν σκοπόν: cf. 172n312.

³²⁰ 509.16: ὅπ' αὐτῆς; *scil.* this composite hypothesis. See, e.g., Neugebauer 1975, 84–88.

³²¹ 509.21 ἀλλ' οὐδέ (further, not even): cf. Denniston 1966, 21–22.

509.21 ἢ τῆς ἀπορίας λύσις: cf. *De caelo* 292a10–14, b25–27.

509.21 χώραν: lit. 'place or room'.

³²² 509.25–26: see Simplicius' suggestion at 510.9–15. The difficulty is that each planetary system has but one starless sphere in eccentric/epicyclic hypotheses and none in purely eccentric hypotheses.

³²³ 509.30–32: here and in what follows, Simplicius unpacks the Aristotelian assertion that the characteristic or natural motion of an aetherial body is a circular motion about the center of the universe into three claims:

This is why it is true to say that all the heavenly bodies which have the center of the universe as a center move about the center of the universe, whereas all [those bodies] which are outside that center (since they are more particular)³²⁴ move about their own center, just as the [wandering] stars [do] as well as their epicycles and their eccentrics (if there are indeed such bodies in the heavens).³²⁵ These [bodies] do move about the center of the universe, even if [they are] not [performing] their characteristic motion [about this center] but the [motion] of the sphere carrying them, [a sphere] which is homocentric with the universe. And in this way at least, Aristotle's principle that every body that moves in a circle moves about the center of the universe would in fact be true, unless someone stipulates that it move [in this way] in accordance with its characteristic motion.³²⁶ [510.1] [5]

The solution of [Aristotle's second] problem will have standing in part even in the case of these hypotheses, since in these instances too it is in a sense true to say that '*nature equalizes and produces a certain order by assigning many bodies to one motion and many motions to one body*'.³²⁷ The reason is that, even if each [body] performs its own motion as a single [motion], all [the bodies] beneath the fixed [sphere], furthermore,³²⁸ perform its motion—that is, the epicycles perform this [motion] as well as the [motion] of the homocentric or eccentric [deferent circles], and the [wandering] star (which he called one body)³²⁹ [performs] the [motion] of the [10]

-
- the characteristic or proper motion of an aetherial body is that motion which it performs in so far as it is ensouled, that is, that motion which *qua* living aetherial creature it performs by nature;
 - such circular motion is by definition motion about the internal center by which the circularity of the motion is defined; and
 - aetherial bodies do also move in circles about the center of the universe.

³²⁴ 510.1 μερικώτερα: Aujac et al. [1979, 189n1] have 'plus "particuliers"', and suggest that Simplicius is borrowing the term from logic and intends a contrast with the universal. More likely is that he is referring to the wandering stars viewed as creations of the celestial sphere [cf. 55n52, 485.23–27, 486.29–487.2].

³²⁵ 510.1–2: Simplicius accepts the thesis that the stars rotate or spin [454.23–456.27 with Comment 11.05, p. 221]. For debate about whether motion on eccentric and epicyclic circles is indeed circular, see Heiberg 1894, 32.1–11 with Comment 12.27, pp. 284–288.

510.2–3: recall Simplicius' remarks at 488.10–14, 25–30; 492.25–28.

³²⁶ 510.7 προσθεῖν: *scil.* 'puts it to us'. Cf. Grosseteste's 'apponat' [Bossier n.d.a, 195.7].

510.7–8: I take the stipulation to be that a body's motion about the center of the universe must be a proper motion and not one that is incidental or forced.

³²⁷ 510.9–11: cf. *De caelo* 293a2–4.

³²⁸ 510.12 ἀλλὰ καὶ: cf. Denniston 1966, 21.

³²⁹ 510.13–14: cf. *De caelo* 293a3–4.

- [15] epicycle and of the homocentric or eccentric [deferent circle] as well as the [motion] of the fixed [sphere].

Still,³³⁰ the eccentric circles would not be ones moving in a circle, since they do not move about the center but about what is outside the center: that is, since, as [these circles] occupy and leave behind a place in rotating [about the center of the cosmos], they necessitate that there be a void, and since the shape of these circles³³¹ will be strange in that what is inside always cuts off a part of what is outside.

- [20] We will perhaps escape³³² all these [problems] if we fit eccentric spheres in homocentric ones and say that the homocentric [sphere] by moving about its own center causes the eccentric [sphere] (which itself also moves about its own center) to go around.³³³ And we will call all [these pairs of] spheres complete without fearing that in those cases 'body goes through body'.³³⁴

- [25] Sosigenes cleverly raises as well no small number of other astronomical problems for these hypotheses too, problems which would belong to another lecture to examine. But, as it is, he thinks³³⁵ that, by investigating the arguments about the heavens and the heavenly motions and by confirming the demonstrations through which [these motions] are proved to be circular and smooth, that is, ordered (since they appear unsmooth and evidently have ascents and descents), he has provided a conception of what things have been hypothesized by the ancient astronomers³³⁶ and those who came after [them] in order to save the phenomena by means of smooth, circular, and ordered motions.

³³⁰ 510.15–19: Simplicius now considers what happens to an eccentric circle when it is made to go round with the daily rotation. He assumes that motion at a fixed distance about a point is circular only if that point is the center of the universe.

³³¹ 510.18 τὸ τε σχῆμα αὐτῶν: *scil.* the shape that these eccentric circles describe as they go around with the celestial or the homocentric sphere.

³³² 510.19 μήποτε ... διαφευξόμεθα: Grossteste [Bossier n.d.a, 195.22] has 'ne forte ... effugiamus'; but this seems to me unlikely.

³³³ See Figures 12.13 and 12.14, pp. 196–197.

³³⁴ 510.23 τὸ σώμα διὰ σώματος χωρεῖν. Simplicius is alluding to a well known problem in physical theory that was first raised by the Stoic doctrine of total mixture: cf. Todd 1976, 29–88. Here the (tangential) point seems to be that if each of a number of eccentric spheres is enclosed in a rotating homocentric sphere or, better, a rotating homocentric spherical shell, there is no longer any danger that they will come into contact [cf. Aujac et al. 1979, 190]. Mueller's 'not fearing to say that in their case a body passes through a body' [2005, 49] misses the point.

³³⁵ 510.26 νὺν δὲ ἔδοκει: a philosophical imperfect [cf. Smyth 1971, §1903] not, as Mueller [2005, 49] has it, the apodosis of a contrary-to-fact conditional ('But it would seem').

³³⁶ 510.31 ἀστρόνιοι.

Now, if this is more fitting to chapters³³⁷ about the heavens than to ones about first philosophy, none of us will criticize the rather lengthy digression from the [present] chapter, since it has come about at the right time.³³⁸ But we must return to what comes next in Aristotle's chapters.

[35]

³³⁷ 510.31–32 τοῖς ... λόγοις: *scil.* the sections of a treatise.

³³⁸ 510.33 μηδεὶς ἡμῶν αἰτιάσεται τὴν πλείονα τοῦ λόγου παρέκβασιν. Mueller's 'no one will accuse us of turning the discussion aside' [2005, 50] misrepresents the syntax. On the philosophical schools in Athens and Alexandria, see Watts 2006 and Wildberg 2006.

510.33–34 εἰ κατὰ καιρὸν εἴη: lit. 'if it should have come about at the right time'. In context, «εἰ» means 'since': cf. Smyth 1971, § 2246.

FIGURES

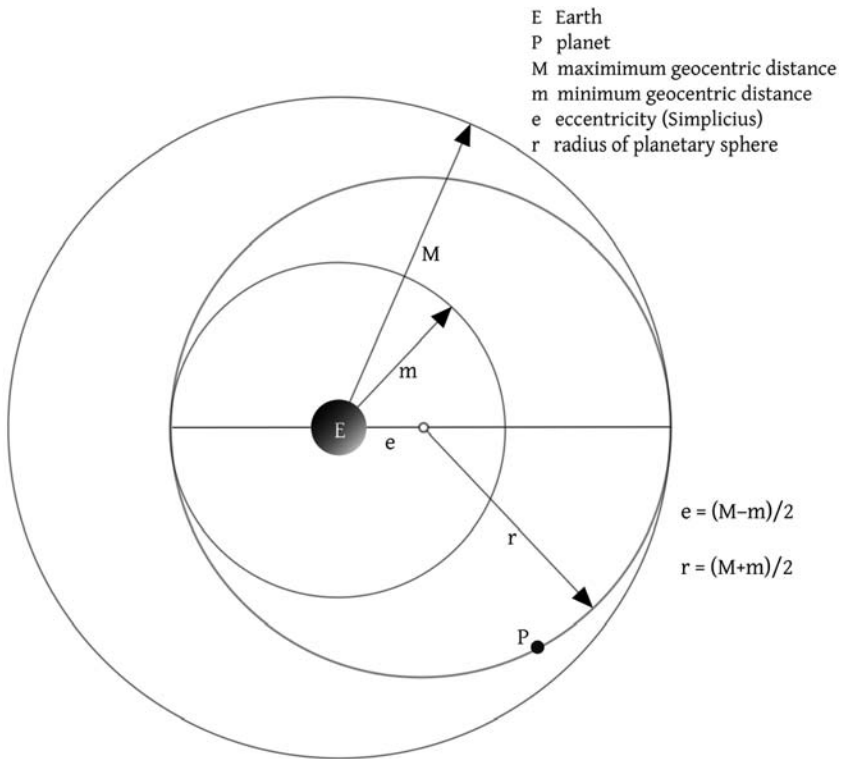


Figure 10.01. The eccentricity of a planet according to Simplicius

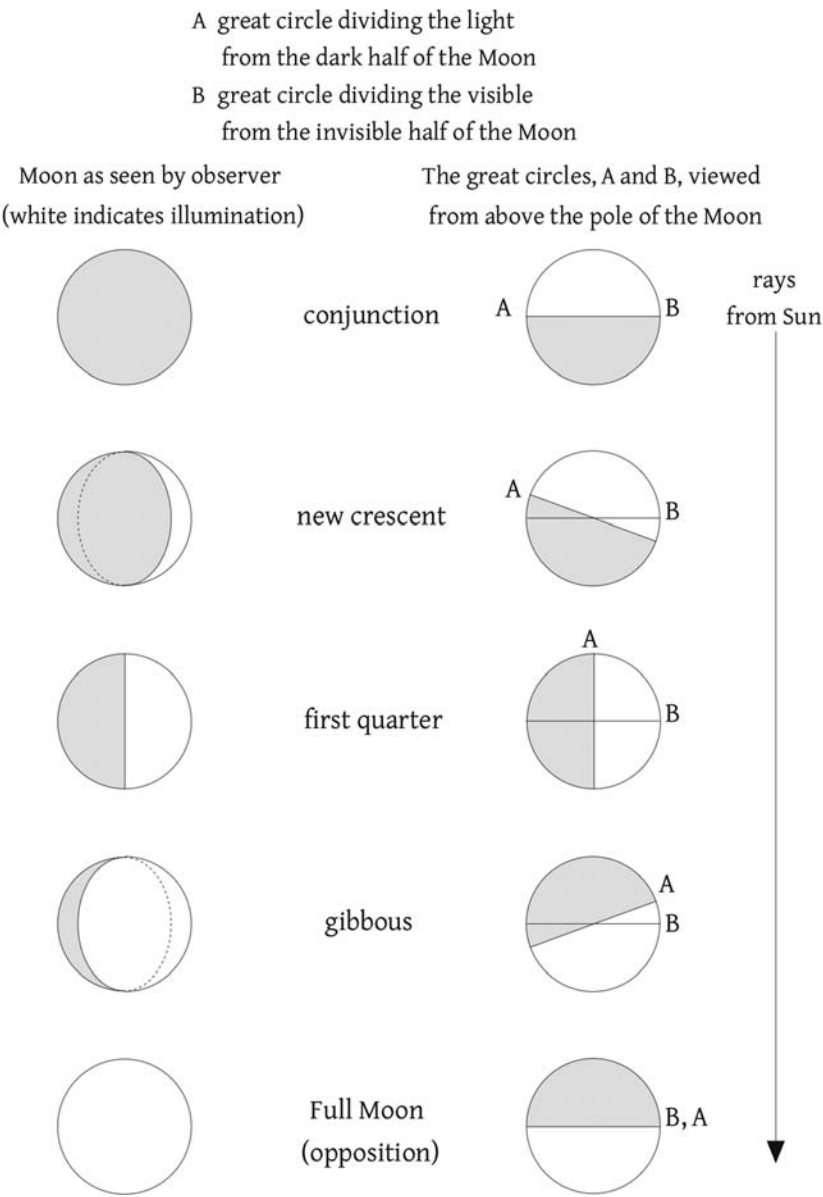


Figure 11.01.(a). Lunar phases: Conjunction to Full Moon

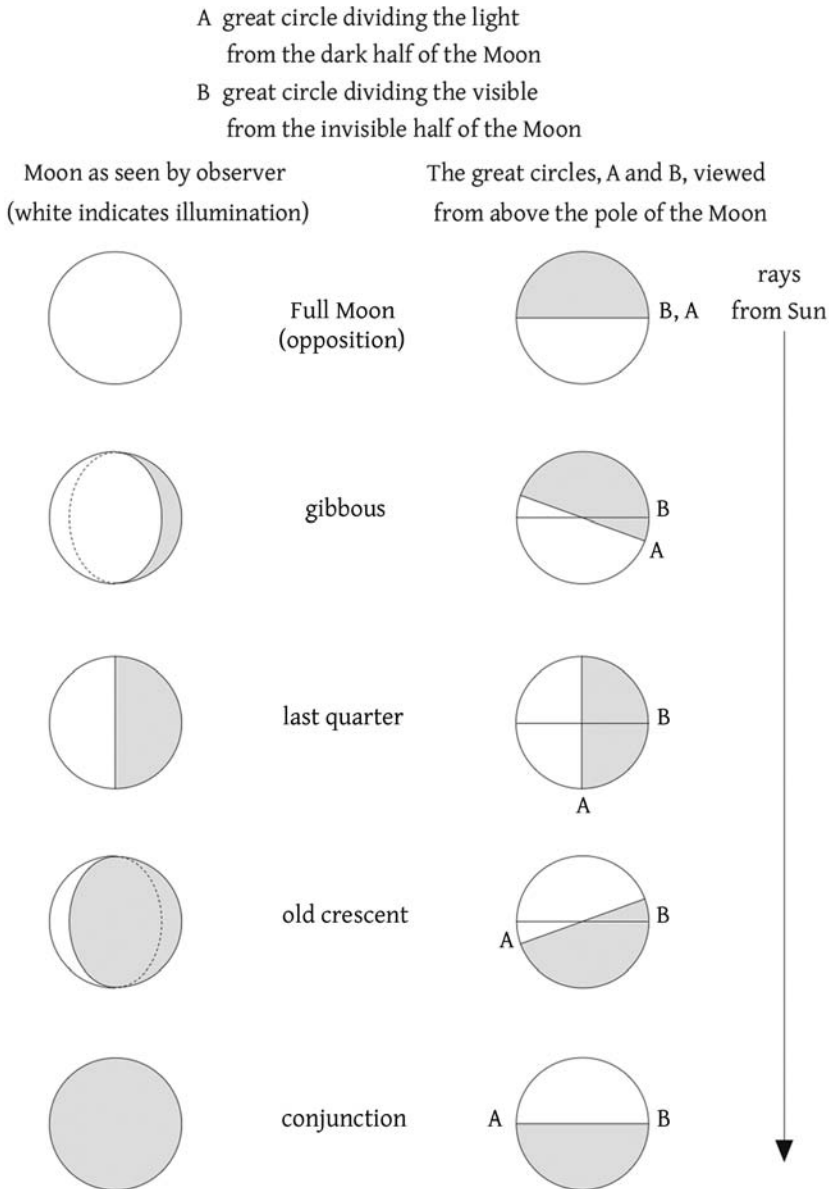


Figure 11.01.(b). Lunar phases: Full Moon to conjunction

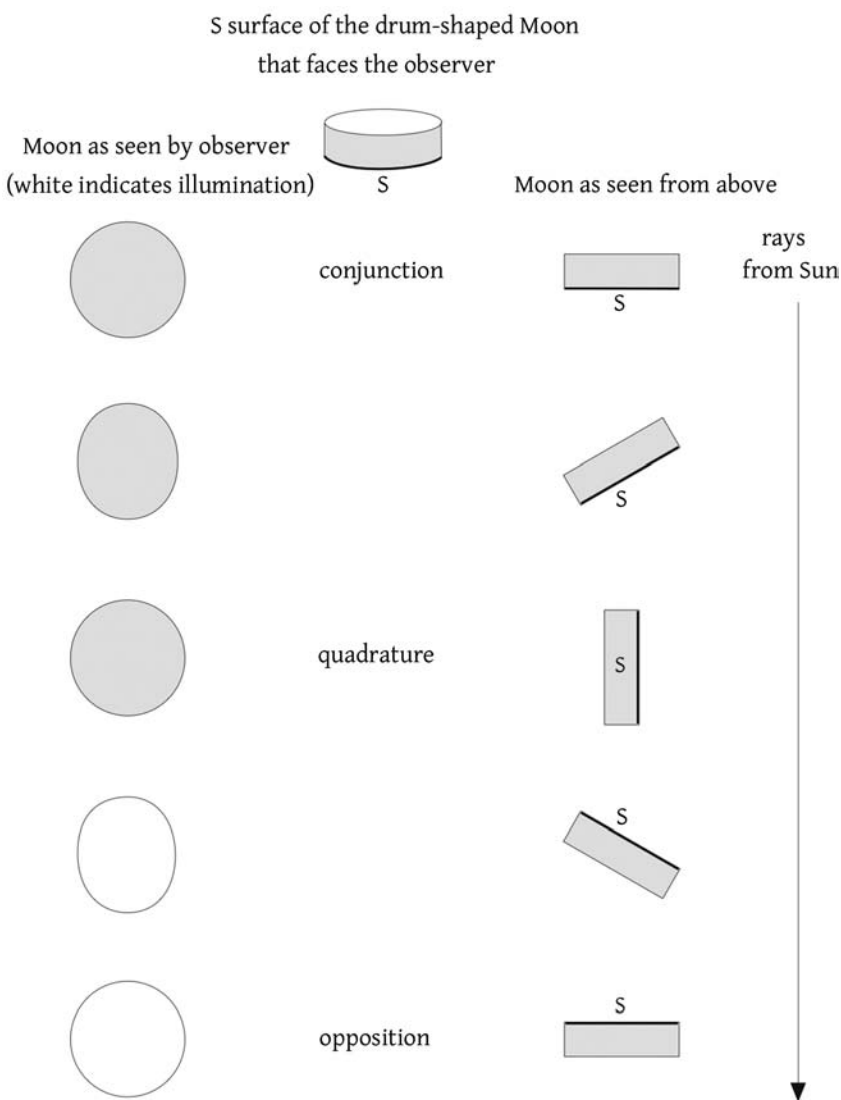


Figure 11.02. The phases of a drum-shaped Moon: Conjunction to opposition

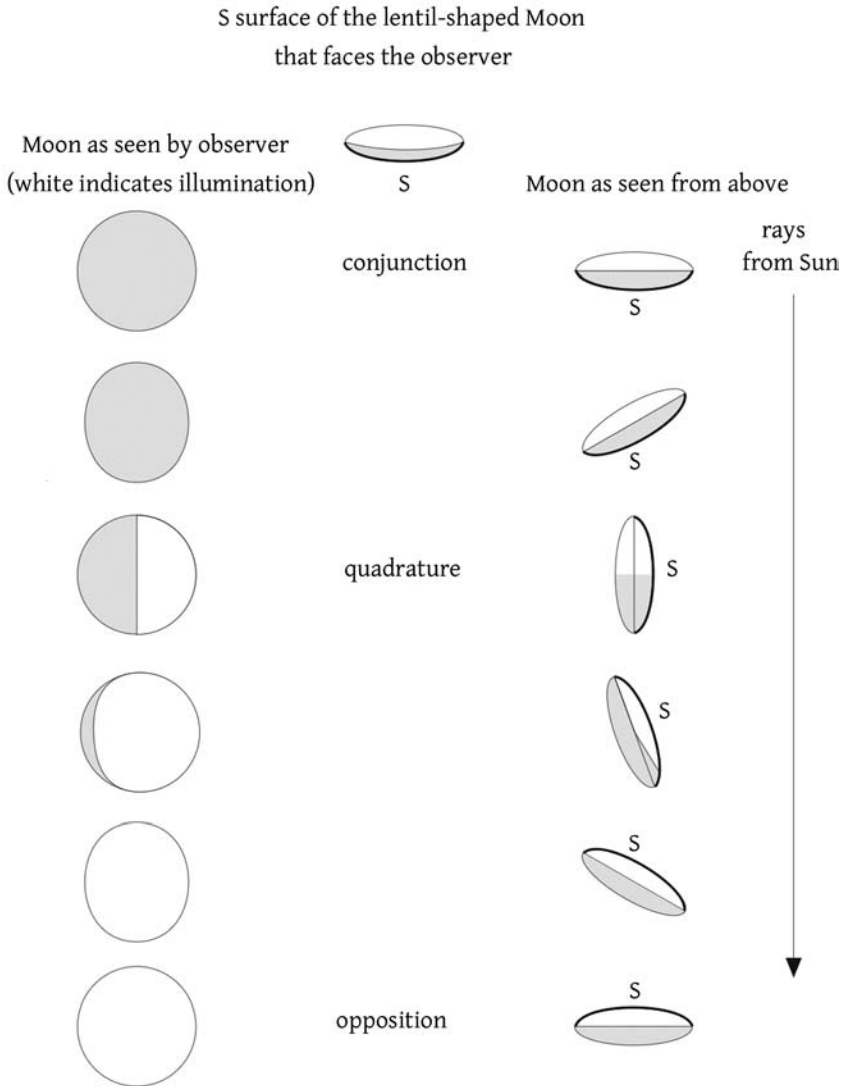


Figure 11.03. The phases of a lentil-shaped Moon: Conjunction to opposition

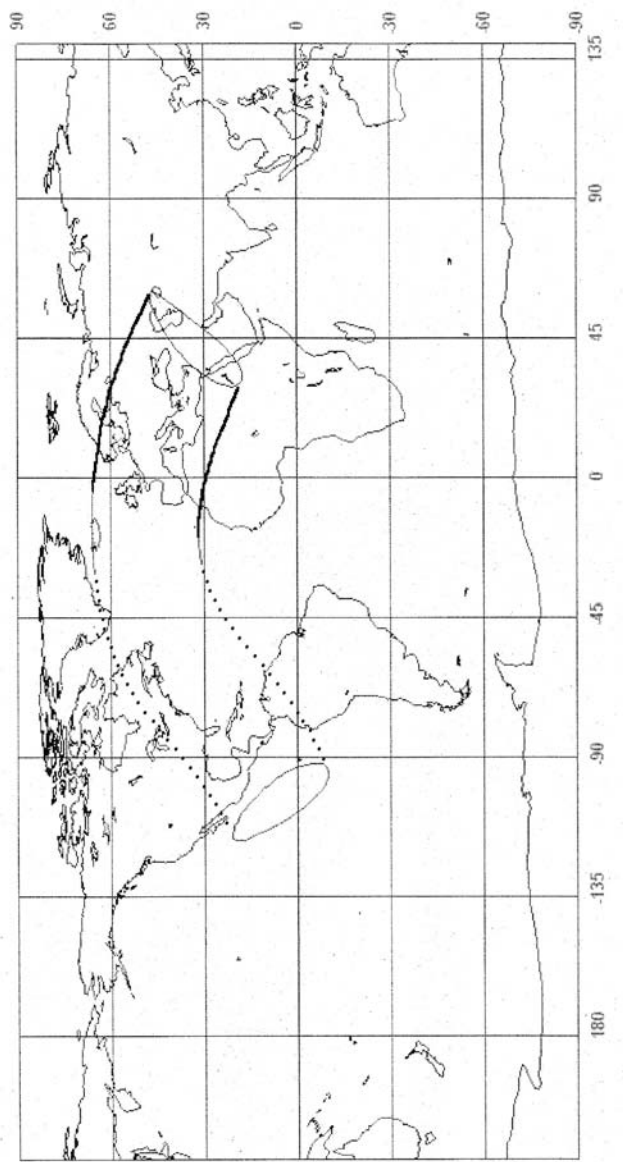


Figure 12.01. The occultation of Mars (–360 Mar 20)
(Courtesy of Dave Herald)

The dotted black lines indicate daytime; the thin black lines, evening twilight; and the thick black lines, nighttime. A pair of lines of the same sort defines the region in which the occultation was ‘visible’.

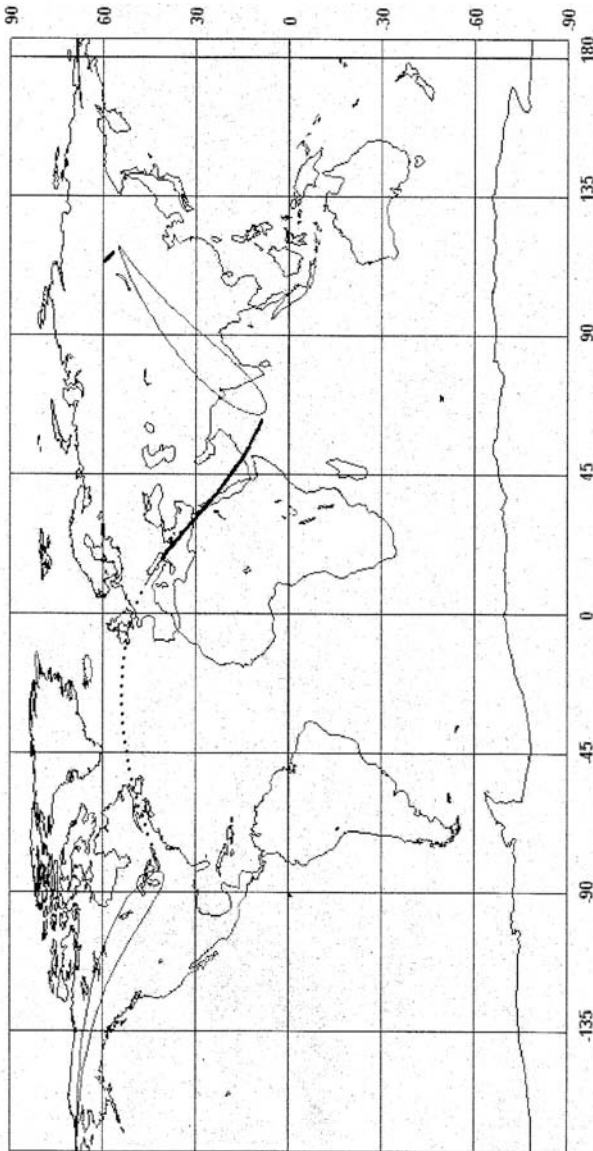


Figure 12.02. The occultation of Mars (–356 May 4)

(Courtesy of Dave Herald)

The dotted black lines indicate daytime; the thin black lines, evening twilight; and the thick black lines, nighttime. A pair of lines of the same sort defines the region in which the occultation was 'visible'.

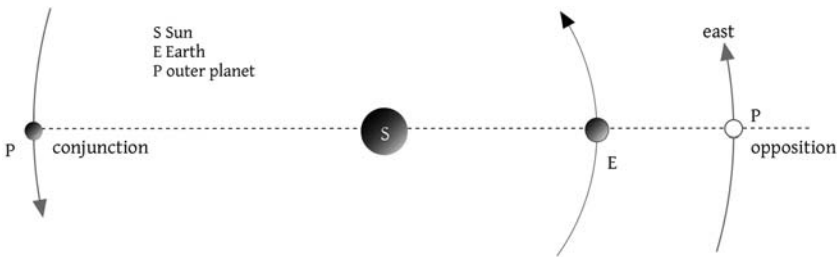


Figure 12.03. The hypotheses for the Sun

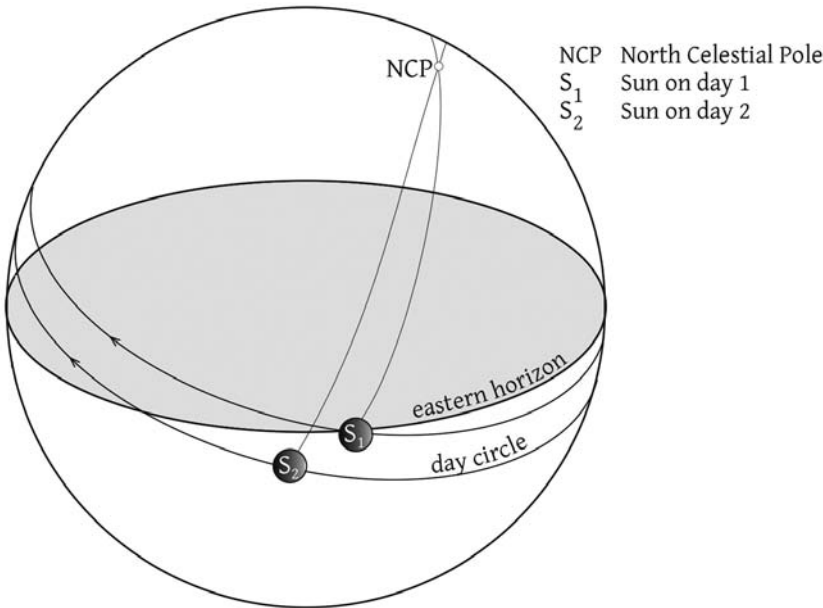


Figure 12.04. The length of the day
The interval from sunrise to sunrise takes longer than one full revolution of the cosmos: S_1 crosses the eastern horizon before S_2 .

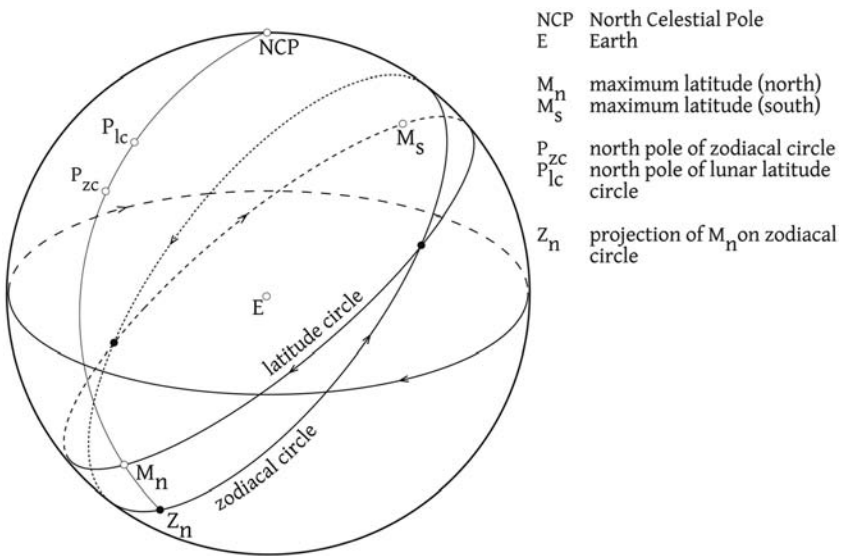


Figure 12.05. The motions of the Moon

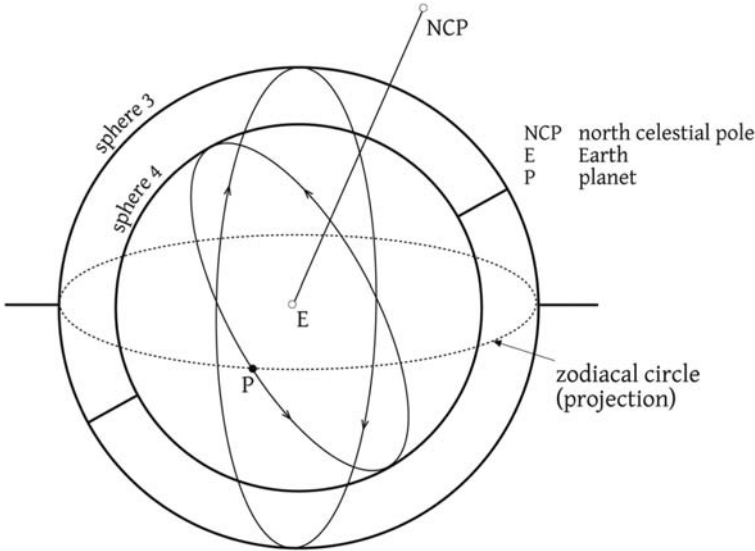


Figure 12.06.(a). Placement of the third and fourth planetary spheres

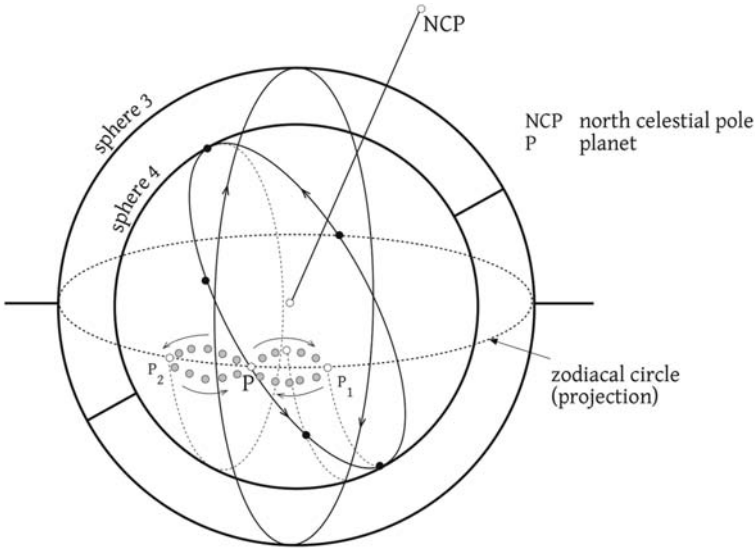


Figure 12.06.(b). Generation of the hippopede. The distances P_2P and PP_1 are equal to the planet's greatest displacement in latitude.

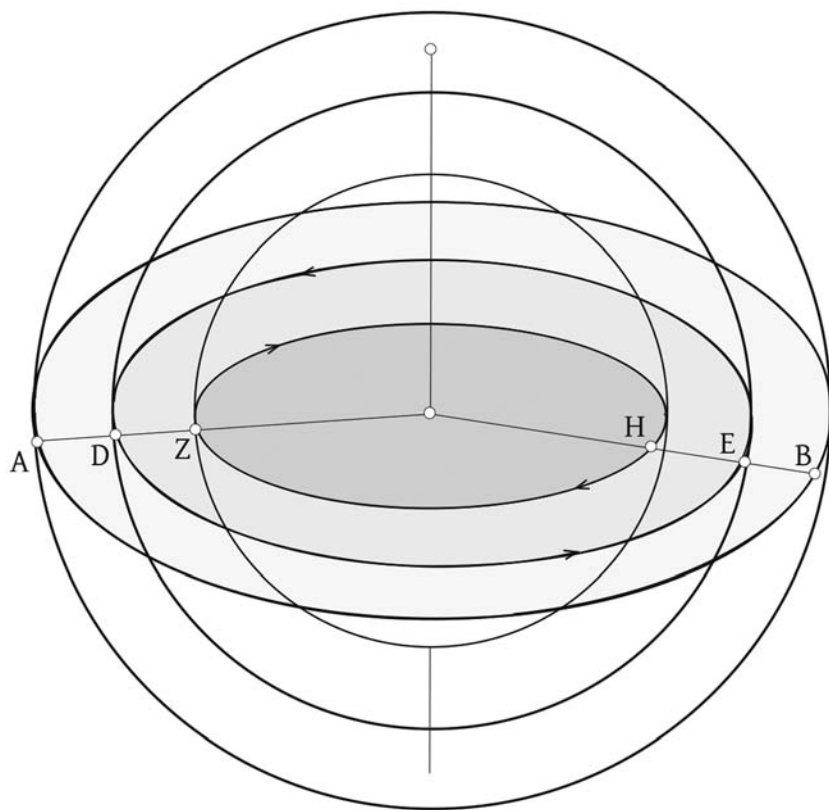


Figure 12.07. Homocentric motion (1)

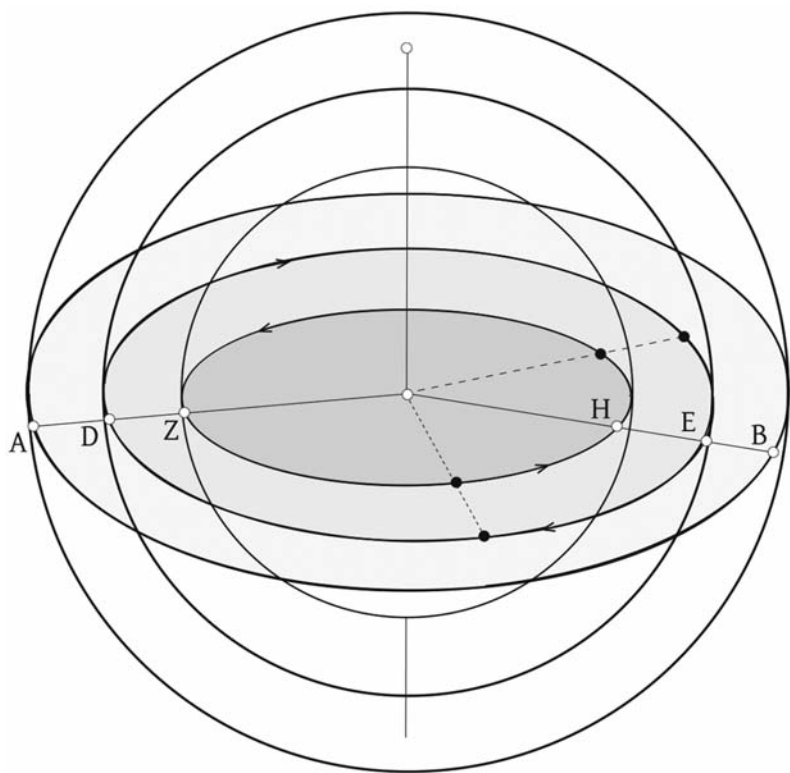


Figure 12.08. Homocentric motion (2)

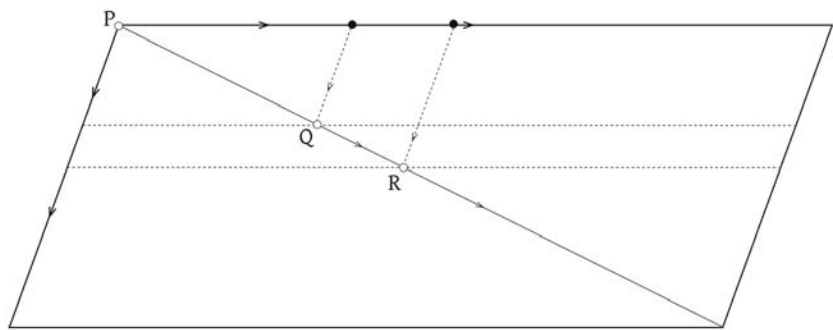


Figure 12.09. An analysis of compound motion

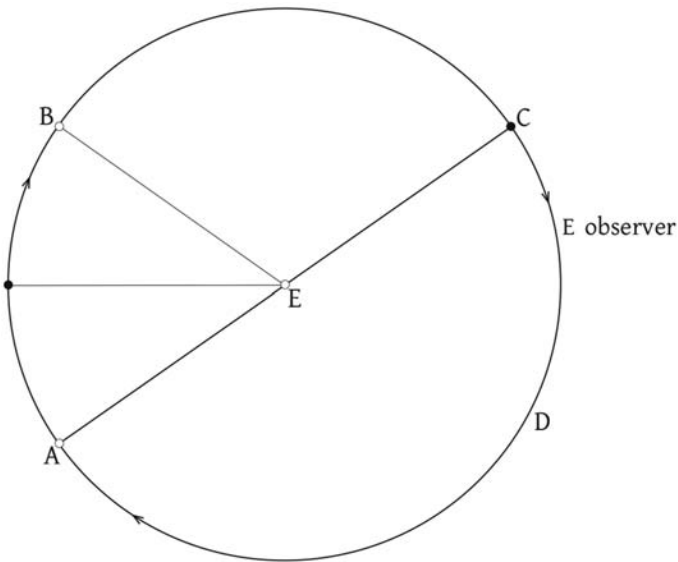


Figure 12.10.(a). Motion on a circle homocentric to the observer

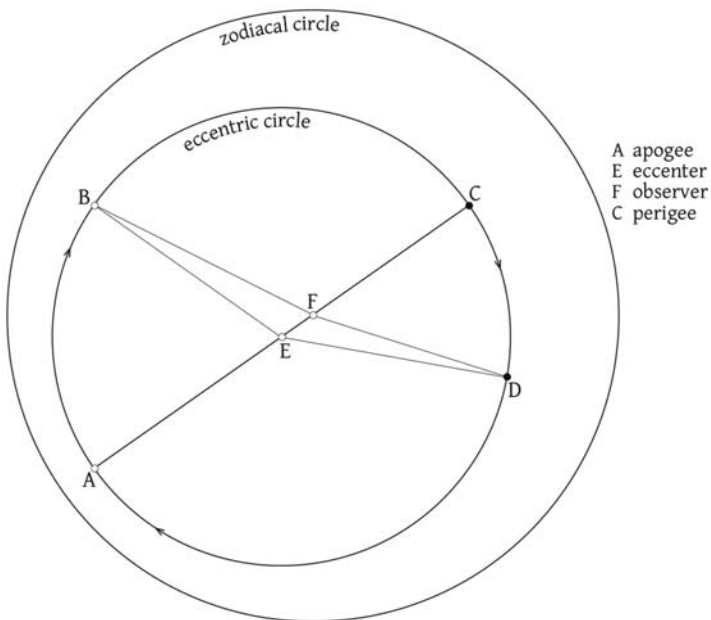


Figure 12.10.(b). Motion on a circle eccentric to the observer

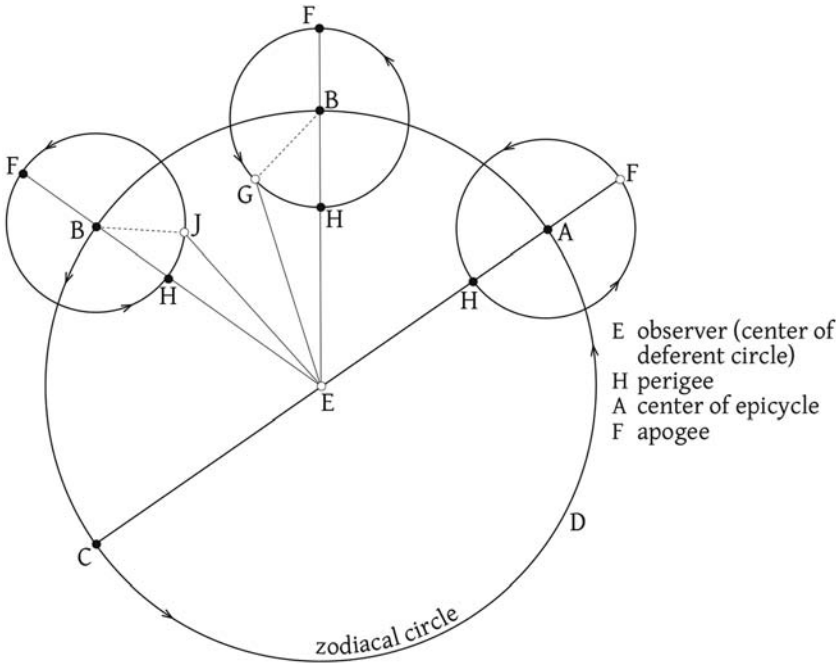


Figure 12.11. Motion on an epicycle with deferent homocentric to the observer

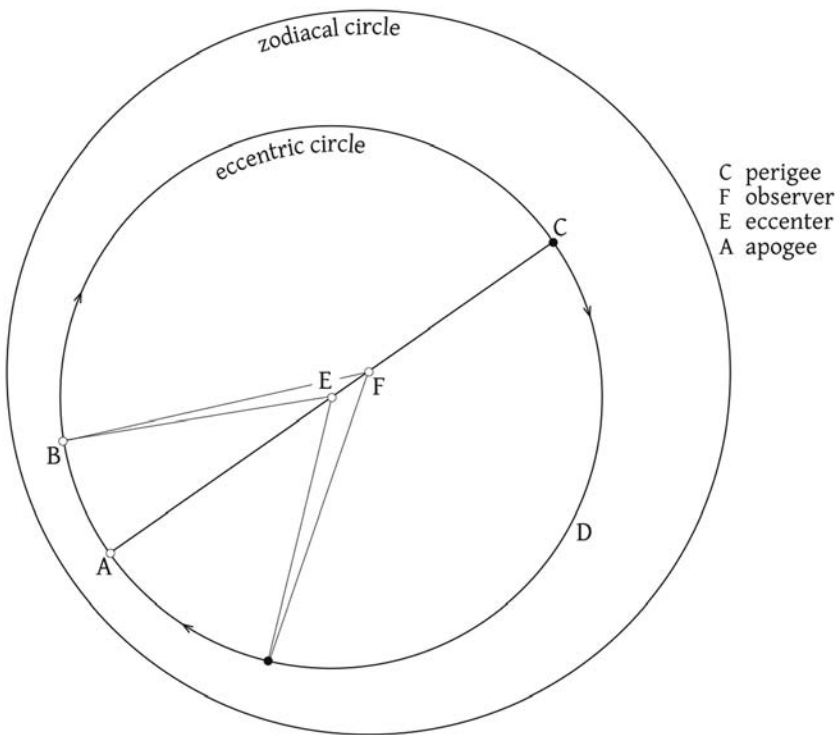


Figure 12.12. Apparent motion near apogee
on a circle eccentric to the observer

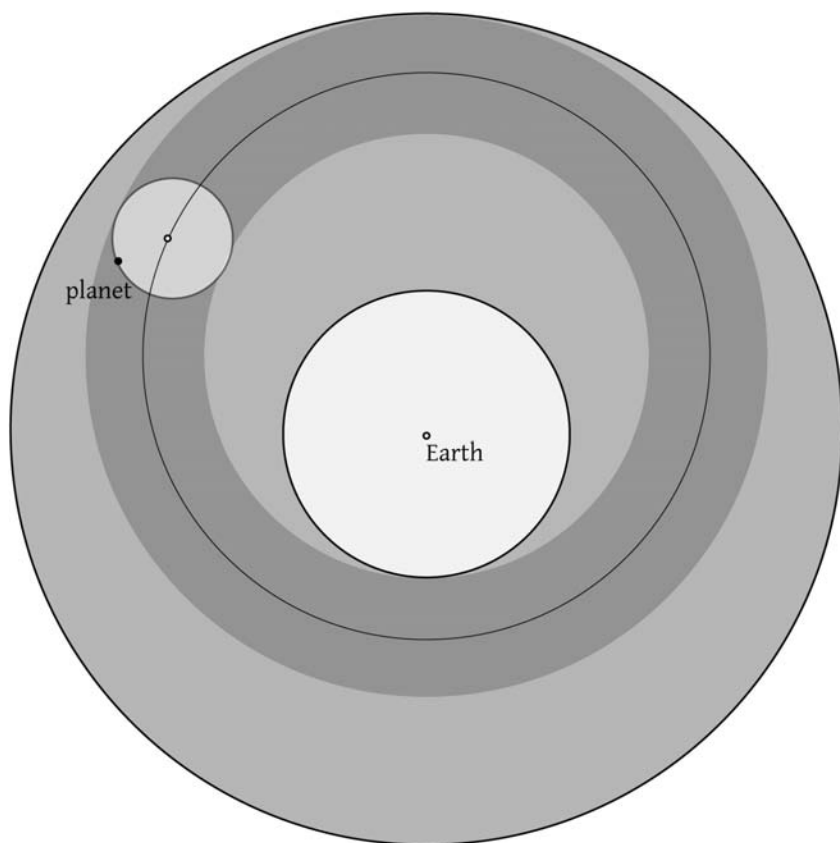


Figure 12.13. Epicyclic planetary hypothesis in spherical shell

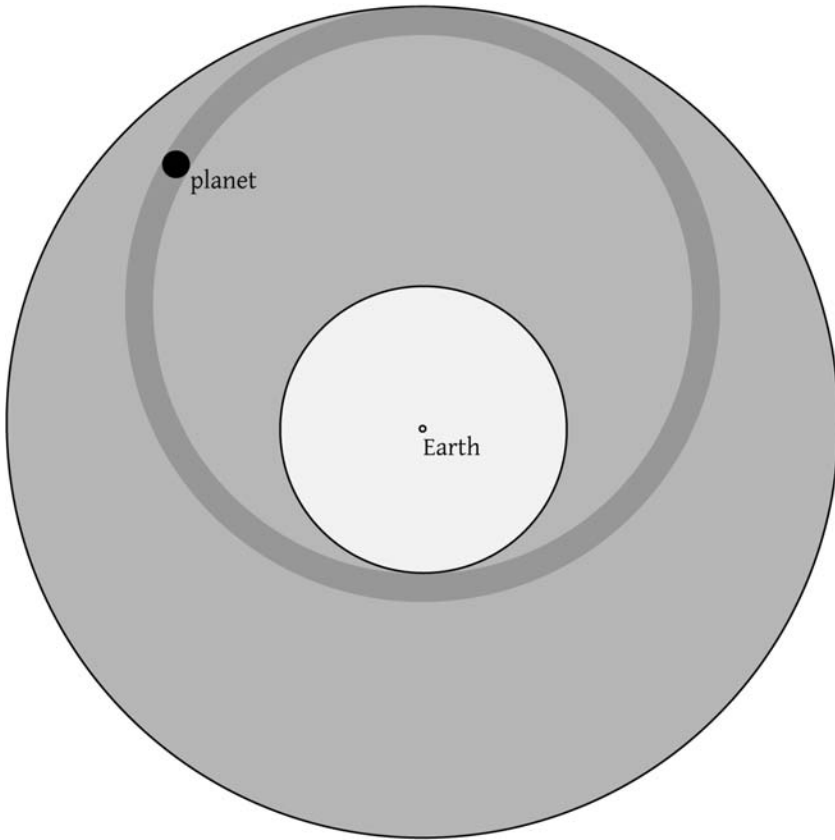


Figure 12.14. Eccentric planetary hypothesis in spherical shell

COMMENTS

A Question of Proportionality

Chapter 2.10 of the *De caelo* opens with a question that is relevant to the two characteristic motions known to belong to any planet in Aristotle's time, its diurnal motion and its motion in longitude along the zodiacal circle; and it seems to affirm a proposition that is arguably true of both—namely, that there is a direct proportionality between the motion of a planet and its distance. Presumably, the diurnal motion would be viewed as a linear speed, since the diurnal angular speeds of the planets are all the same and since their diurnal linear speeds do indeed vary directly with the distance of the planet in question from center of the Earth. As 291a34 ff. make clear, however, Aristotle is really thinking of the planetary longitudinal or sidereal motions. In this case, the motion of a planet is faster if the planet completes its eastward circuit in longitude through the zodiacal constellations and returns to a given fixed star in a shorter time, that is, if it has a shorter sidereal period. Moreover, the distance to which this motion is proportional is to be that from the celestial sphere, *not* from the center of the Earth.

There are two points worth noting here. First, this proportionality of the planets' longitudinal motions and their distances from the fixed stars is simply not the same as the proportionality of their motions and their distances from (the center of) the Earth; that is, the existence of a proportionality established one way does not entail the existence of the other. Second, there is not enough information given here to decide whether Aristotle has in mind anything as specific as linear or angular speed when he discusses the planetary motions in longitude.

τὸ ἄστρον / ὁ ἀστήρ

In general, Aristotle and Simplicius use «τὸ ἄστρον» and «ὁ ἀστήρ» to designate a star whether it is fixed or wandering (i.e., planetary). Usually, the context makes clear whether they are thinking of one or the other kind of

star; and when it does, I translate these terms accordingly by '[fixed] star' and '[wandering] star' or '[planetary] star' rather than simply by 'star', in the interest of clarity. There are, however, occasions when they refer to both kinds of star at once, as Aristotle does at 291a26–28 and here. And, again, rather than render these occurrences simply by 'star', I think it better to use 'heavenly body'. After all, this is standard English usage.

Nevertheless, the translation does entail a problem. In *De caelo* 2.8, Aristotle argues that τὰ ἄστρα neither rotate on an internal axis nor roll, but are carried round by their circles (κύκλοι), an argument meant, I think, to stand for all the heavenly bodies, that is, for the planets as well as for the fixed stars. But this means that these ἄστρα do not move of their own accord or by their own nature in a circle about the center of the cosmos. And, so it would seem, they are not made of aether, though they must be, given that this is the only simple body available for their constitution. So how can they be 'heavenly bodies'? They are, of course, 'bodies' in the sense that they are visible. Yet, they are *not* bodies (σώματα) in the sense that the circles, or more precisely, the (invisible) spheres in which they are embedded, are bodies [cf. 293a4–8]. It is these latter bodies that rotate by nature and of their own accord about the center of the cosmos, and so would seem to be made of aether.

Aristotle does not address this difficulty explicitly. Still, his remark in 2.12 that we must stop thinking of the ἄστρα as mere bodies or units with position but no soul [292a17–22] does suggest a response. After all, one might argue, whereas the heavenly bodies are, in the first instance, living animals constituted of aether with one or more rotating spheres as their internal moving, functioning parts, in the second instance, they are what we see—the fixed stars and the planets.¹ These latter bodies would, then, neither be animals themselves nor the proper parts of animals, and might better be compared to the moles or warts on an animal's skin. But this might raise in turn the question of how such visible aetherial bodies come about. The catch here is that, for Aristotle, since they are eternal, that is, without generation or corruption, there can be no material account of the presence of such visible aetherial bodies in the invisible aetherial bodies, only one that is teleological.

¹ When Aristotle describes each celestial sphere as σῶμά τι at 293a8, he is perhaps conceding to the fact that the bodies with which we are familiar are perceptible.

COMMENT 10.03

DE CAELO 291A30 97n3

κινεῖται

Moraux [1965, 79] prints «κινεῖται». But «κεῖται» ('is placed') is found in one ms. and is supported in Moerbeke's translation (1260) of the *De caelo*. Yet, though «κεῖται» would make easier sense and is printed by Pellegrin [2004, ad loc. with 437n1],² «κινεῖται» is better attested. Indeed, it is supported in Grosseteste's translation [cf. Bossier et al. 2004, x] of *De caelo* 2 and of Simplicius' commentary thereon [see Bossier n.d.a, 140.2 *moventur*]. The fact that Simplicius contextualizes 2.10 by referring to an ancient concern with the sizes of the planetary circuits and their distances from the Earth does not help with this textual question.

COMMENT 10.04

DE CAELO 291B9–10 97n7

οἱ μαθηματικοί

A μάθημα is a thing learned, a body of learning or knowledge, and, hence, a science. The noun itself is formed from the verb «μανθάνω» (to learn, whether by study, practice, or experience) and has the force of the neuter perfect passive participle treated substantively. Hence, a basic sense of «οἱ μαθηματικοί» is 'men of learning', 'men of science', or even just 'scientists'. But, in Aristotle's usage, there is a nuance: as is clear in *Phys.* 2.2, a key text in the present study, the μαθηματικοί are scientists devoted to the study of Nature who characteristically define their subject matters by focusing their attention on (*scil.* by ἀφαίρεσις of) some quantitative aspect of physical objects and then employing arithmetic and/or geometry to make deductions about these objects. Thus, as he uses the term, it includes arithmeticians, geometers, and astronomers. As a matter of policy, then, I will render «μαθηματικοί» by 'mathematical scientists' or even just by 'scientists' when the use of mathematics is evident in context.

But what will not do is rendering «οἱ μαθηματικοί» by 'the mathematicians'. First, Aristotle's understanding of the μαθηματικός plainly differs from our notion of a mathematician; and so such a translation really does mislead. Further, though there is evidence that «μάθημα» was paradigmatically

² The occurrence of «κινῆσεις» in 291A34 is not relevant since the thought is different: but see Allan 1955, ad loc.

applied in this period to any science that uses mathematics, it does not follow by any means that such a mathematical science was to be viewed simply as mathematics, as a branch of mathematics such as arithmetic or geometry, or even as applied (in contradistinction to pure) mathematics. At least, such an inference needs good argument, given that it does not capture how the sciences were differentiated in the fourth century BC.³

As for Simplicius, his usage is in accord with Aristotle's, especially when he is attending closely to what Aristotle writes [cf. 454.12]. Moreover, notably in his commentary on 2.10–12, Simplicius follows Aristotle in addressing the same people as μαθηματικοί and as ἀστρονόμοι or ἀστρολόγοι (the latter terms both translated there by 'astronomers'). Nevertheless, even in these instances, I will preserve the verbal distinction in continuing to translate «μαθηματικοί» by 'mathematical scientists' (or 'scientists' when warranted), if only to assist the reader in thinking about the meaning of «μαθηματικοί» and its role as a marker in the development and organization of the sciences in antiquity.

98n8 COMMENT 10.05

IN DE CAELO 471.1

«καταλαμβάνω» and Its Cognates

The verb «καταλαμβάνω» has a wide range of meanings; but in this part of the commentary at least, it generally indicates seizing, taking, or receiving. When the 'taking' is done by the mind, it signifies comprehending, detecting, determining, understanding, accepting, and so forth. It is difficult to find a single translation that works well in all occurrences of the verb and of the related substantival and adjectival forms («κατάληψις», «καταληπτικός», respectively). Thus, in 471.1, the passive «καταλαμβάνονται» broadly means 'are understood', 'are made known', or even 'are ascertained'. But given that the objects understood are numerical ratios, English usage would naturally incline here to 'are known', given that what is understood is their value. Cf. «καταληπτή» ('be knowable') at 476.18. Yet, in 471.7–8, «ἀπὸ τῶν ἐκλείψεων τὴν ἀφορμὴν τῆς καταλήψεως λαβόντα», «καταλήψις» indicates a process of detection or determination by which quantitative values are known and the aorist participle from «λαμβάνω», a simple taking or receiving (if aspect predominates) or a having taken or received (if tense is important). In 474.19,

³ See, e.g., Plato, *Resp.* 7 and Aristotle, *An. post.* 13.

however, «κατείληπται» signifies detection that here borders on discovery and so is perhaps better rendered by ‘has been found’. In sum, it seems to me prudent to render this important verb and its cognate forms as the context requires rather than to impose a single meaning.

COMMENT 10.06

IN DE CAELO 471.9 99n13

παραβολή

Heiberg conjectures «μεταπαραβολή» on the basis of A's «μετὰ παραβολή»—the mss DEFc have only «παραβολή». «παραβολή» is not a technical term in astronomy *per se*, though it does appear in computations. My suspicion is that Simplicius uses it because it is in fact a Platonic term at *Tim.* 40c4 for a relation between planets.⁴ But what does it signify for Simplicius? Plato's text is no help on its own. In his commentary, Proclus suggests that

by «παραβολαί» [we should understand] the arrangement of [the planets] in longitude when they differ in latitude or in altitude,⁵ I mean, their co-risings and co-settings. [Diehl 1903–1906, 3.146.7–9]

This interpretation, which takes a planetary παραβολή to be a ‘juxtaposition in longitude that results in a co-rising or a co-setting with another body, provided that the latitudes are also suitable’,⁶ is admittedly possible; but it is also at odds with Plotinus’ account in which the planetary παραβολαί are different from their risings and settings [see *Enn.* 3.1.5.1–4]. For their part, Liddell, Scott, and Jones [1968 s.vv. μεταπαραβολή, παραβολή] suppose that Simplicius means ‘conjunction’. But this seems to me unlikely. After all, well before Simplicius’ time, the established term of choice for conjunction was «σύνοδος»,⁷ where two bodies are said to be in conjunction if they are located at the same degree of longitude. Moreover, given that Simplicius does use «σύνοδος» properly at 480.8 and 10, that he seems to have an event analogous to a solar eclipse in mind, and that «παραβολή» has a technical sense of ‘application’ or ‘covering’,⁸ I propose instead that he is using «παραβολή» at 471.9 to signify a coincidence of two bodies in which

⁴ Cf. Grosseteste's ‘ab ... appositione’ [Bossier n.d.a, 141.3] and Moerbeke's ‘a comparatione’ [Bossier n.d.b, 449.1].

⁵ κατὰ τὸ βάθος (lit. in depth): *scil.* in distance from the Earth.

⁶ Cf. Festugière 1966–1968, 4.187.

⁷ See, e.g., Geminus, *Intro. ast.* 8.1, 9.16.

⁸ Such usage is common in geometrical texts as early as Euclid's *Elements*.

one covers the other (partially or totally). Solar eclipses are an obvious species of such coincidences and occultations, the interposition of one body between the observer and another body;⁹ are another. If Simplicius is alluding to occultations,¹⁰ it would have been clearer and more precise if he had followed established usage by writing «ἐπιπροσθήσεως» instead, as Theon of Smyrna and Proclus do.¹¹ (Note, however, that in Iamblichus' *De myst.* 9.4.20–25 «παράβολή» means 'occultation'.) As it is, Simplicius unhelpfully includes phenomena not visible to the naked eye such as the transits of the Sun by Mercury and Venus.

99n14 COMMENT 10.07

IN DE CAELO 471.11

οἱ περὶ Ἱππαρχον

Locutions of the type, «οἱ περὶ Ἱππαρχον», (literally, 'those around Hipparchus') are difficult and the translation proposed here is offered with due diffidence.¹² In general, though «οἱ περὶ Ἱππαρχον» is often translated by 'the school of Hipparchus', this may suggest too much both about the organization of the thinkers in question and about their doctrinal coherence. The alternative, 'the followers of Hipparchus', would be preferable, though perhaps not as good as 'those associated with Hipparchus' or just 'the Hipparchans'. As I have pointed out elsewhere,¹³ one should bear in mind that the phrase may mean only those who are perceived to share certain assumptions or procedures with Hipparchus, whether they are contemporary with him or subsequent to him. In any case, when this sort of translation is appropriate—as it may be here—we should not take for granted that what is attributed to the Hipparchans must also hold of Hipparchus: such an inference should require more evidence than the mere phrase «οἱ περὶ Ἱππαρχον», since there are many cases in which the (perceived) followers interpreted their leader in a way that changes or goes beyond their leader's

⁹ See, e.g., Hiller 1878, 120.15–19, 122.24–123.4, 131.4–9. Geminus [*Intro ast.* 10.1–6] and Theon [Hiller 1878, 194.20–195.4] treat eclipses as a species of occultation.

¹⁰ See Hiller 1878, 148.5–10, 192.2–193.11.

¹¹ Cf. Hiller 1878, 187.5–13; Diehl 1903–1906, 3.149.13–16. Note that Proclus writes of ἐπιπροσθήσεις. It is perhaps worth noting that the scholiast on *De caelo* 293a3–6 uses the term «ἐκλειψις» in referring to the Moon's occultation of Mars [see Rescigno 2004–2008, 2.285 (his fr. 157a)].

¹² On the obscurity of such locutions in the *Almagest*, see Toomer 1984, 137n19.

¹³ See Bowen and Goldstein 1991, 251.

original meaning. Such is the case with Plato and his late Platonist followers (οἱ περὶ Πλάτωνα), for example.

Still, one cannot rule out the possibility that «ὕπὸ τῶν περὶ Ἱππαρχον καὶ Ἀρίσταρχον καὶ Πτολεμαῖον» amounts to no more than ‘by Hipparchus, Aristarchus, and Ptolemy’, since the «οἱ περὶ» + genitive locution serves on occasion as a formulaic or urbane way of referring to a single person. And one may well incline to this translation given the evidence of Aristarchus’ *De mag.* and Ptolemy’s *Alm.* 5.13–16. Nevertheless, it is possible that Simplicius is referring to specific followers. If he is, the only problematic ones are those said to follow Aristarchus. Plutarch (ca AD 50–120) might be a candidate given that he cites Aristarchus and his treatise at *De facie* 925c, and that Simplicius names Plutarch in his commentary on the *Physica*¹⁴ (though not in his commentary on the *De caelo*).

COMMENT 10.08

IN DE CAELO 471.20

99n16

Larger Bodies Move Faster by Nature

To make sense of this thesis, Mueller [2005, 12] refers the reader to *De caelo* 289b7–290a5; but note that *De caelo* 2.8 concerns the planetary diurnal motions, not their *proper* motions; that is, it concerns the (linear) speeds of bodies moving in circles westwards about a point in the same period. Consequently, it is not strictly relevant to an account of the planets’ eastward motions in longitude. Moreover, though 2.8 does allude to a proportionality,

Therefore, since it is neither reasonable that both move nor reasonable that either one move alone, it remains that the circles move but that the heavenly bodies are at rest and move in that they are fixed in their circles. In fact, in this way alone does nothing absurd follow. In other words, that the speed of the larger circle is faster is reasonable when the circles are fixed about the same center. For, just as in the other [simple bodies], the larger body performs its proper motion faster, so too it is in [bodies] that move [by nature] in a circle. Indeed, of the [arcs] cut off by [lines] from the center, the arc of the greater circle is greater, with the reasonable result that the greater circle will rotate in the same time interval [as the smaller circle]. [*De caelo* 289b30–290a5]

it is one of linear speeds and of distances that are assessed from (the center of) the Earth and not from the sphere of the fixed stars, as 2.10 requires. Yet, Mueller may be right: Simplicius’ question at 471.21–23 may register surprise that what is true of their diurnal motion is not true of their sidereal motion.

¹⁴ Diels 1882–1895, 8.29.

Another possibility is that the claims about the proper motions of larger bodies derive from a creative misreading of 2.10. This misreading (apparently to be found in Alexander's writings [474.7–8]) starts by assuming that this passage must harmonize with Plato's account of the division of the world soul and the creation of the heavenly bodies [*Tim.* 34b10–39e2], and so construes the distances in this proportionality from the (center of) the Earth. Next, in the same vein, it supposes that Aristotle's assertion of proportionality in the planetary motions eastward is to be taken quantitatively, that is, as a thesis to be expressed in numbers. It then reasons that, since this proportionality plainly does not hold of the planet's sidereal periods¹⁵ or, therefore, of their angular speeds, it must hold of their linear speeds. And so, if their distances from Earth are sufficiently great, the upshot is that larger bodies (*scil.* spheres) may be said to move faster by nature. In this instance, then, Simplicius' question registers surprise that the larger bodies move faster but still take more time to complete one cycle.

100n21 COMMENT 10.09

IN DE CAELO 472.5–7

The Two Planetary Motions Thus Far

There is no good evidence in the *De caelo* prior to 2.12 that Aristotle views the planets as having more than two motions, that is, motions in addition to their diurnal and sidereal motions. S. Leggatt proposes that *De caelo* 288a13–17,

Of what has been said about the motion [of the heavens], next would be to expound that it is smooth and not unsmooth. I mean this about the first heaven and the first motion, since the numerous motions in the lower regions are in fact unified.¹⁶

[Leggatt 1995, 25–26]

affords such evidence. But Leggatt mistakenly assumes that Aristotle is referring to the compounding of several motions into a single motion in the case of each planet. If this were correct, the remark would be quite illogical and not an integral part of the chapter.¹⁷ The remedy lies in seeing that the passage concerns the daily rotation of the celestial sphere, and that the only planetary motions which can sensibly be said to come all together into one thing are their diurnal motions—each planet has its own distinct diurnal motion precisely because it has its own peculiar linear speed, where

¹⁵ See Comment 12.18, pp. 268–269.

¹⁶ *De caelo* 288a16–17 συνεληλύθησαν εἰς ἓν: literally, 'come together into one thing'.

¹⁷ See Easterling 1961, 145–146.

these speeds are such that the planet completes one westward revolution in the same period as the celestial sphere. Thus, Aristotle quite reasonably declines in 2.5 to discuss the diurnal motions of the planets, since it will be sufficient for his purposes to deal with the diurnal motion of the celestial sphere (which causes these planetary diurnal motions).

COMMENT 10.10

IN DE CAELO 472.13–14 101n26

ἀναγκαῖον ... βίαιον μόνον

I originally translated «ἀναγκαῖον γὰρ οὐ τὸ βίαιον μόνον» by ‘since there must not be only what is forced’ [Bowen 2003b, 32], a turn of phrase that Andrea Rescigno rightly found misleading.¹⁸ His own ‘Infatti, necessario non è solo ciò che è imposto’ is better.¹⁹

But what is the scope of Simplicius’ remark? If one construes it narrowly, he is only emphasizing that, in Alexander’s response to the suggestion that both the planetary motions are contrary to nature, the two causes *must* coincide (or run together). However, if one construes it more generally as a claim about the planetary motions apart from the immediate context, then it may be seen as a nod to Aristotle’s argument that celestial motions are necessary without qualification (ἐξ ἀνάγκης ἀπλῶς) and perhaps as well to the view that these motions are also necessary hypothetically or conditionally (ἐξ ὑποθέσεως) because the cosmic order could not exist without their being as they are, that is, without the planets choosing to move as they do.²⁰

COMMENT 10.11

IN DE CAELO 473.15 103n40

A Lacuna?

Heiberg suspects that there may be a lacuna here and supplies in his *apparatus*:

αἱ δὲ μᾶλλον ἐξελεθοῦσαι τὴν μὲν τῆς ἀντιφερομένης θάττον κινούνται, τὴν δὲ τῆς ἀπλανοῦς βραδύτερον

¹⁸ Rescigno 2004–2008, 2.280–281.

¹⁹ Rescigno 2004–2008, 2.277.

²⁰ See, e.g., *Meta.* Δ.5, *De part. an.* 639b21–640a2, *De gen. et corr.* 2.11.

And the ones that go out more [from the fixed sphere] perform the motion of [the nature] which moves in the opposite direction faster, but the motion of the fixed [sphere] more slowly.

Such disturbance in the text, however, which is signaled *perhaps* by the unanswered $\mu\acute{\epsilon}\nu$ in 473.14, must have occurred early in the text's transmission. Grosseteste [Bossier n.d.a, 144.2–5] has only

illi quidem cognatum motum velocius moventur, eum autem qui contralatae naturae tardius ceu neque sincere aliquialiter secundum illam stantes quemadmodum lunae sphaera ...

and Moerbeke [Bossier n.d.b, 458.6–9],

eo quidem qui illius congenito motu citius moventur, eo autem qui contramote nature tardius, tamquam neque sincere aliquialiter secundum illam existentes, sicut lune spera

In any case, 473.7–12 explain why the planets each complete a revolution westward in a day and affirm the proportionality sought between the sizes of the planetary spheres and their (*scil.* linear) speeds. 473.12–16 focus on the planetary revolutions eastward. These lines relate the differences in the periods of these revolutions to differences in the blending of a planet's substantial nature: it is supposed that each planet's eastward motion is the outcome of a blending of a nature that goes eastward with a nature that goes westward; and that this blending is in each case determined by the planet's proximity to the fixed sphere. What is new is that Simplicius also characterizes this blending as the outcome of two motions, a vector sum if you will, thus prefiguring the treatment of motion in the astronomical digression in the commentary on *De caelo* 2.12.

For my part, I doubt that there is a lacuna. The mention of the sphere of the Moon [473.16–19] is meant primarily to illustrate the explanatory remark that the planets are not constituted only by a substantial nature to move eastward, and there is no way to do this in a particular case without acknowledging its separation in distance and substance from the fixed sphere (or from Saturn).

Planetary Bodies as Hypostases

For Simplicius, while the simple bodies in the sublunary domain change into one another by temporal processes of coming-to-be that entail the replacement of opposites, the simple body found in the superlunary domain

exhibits variations that are the outcome of atemporal processes identical to those by which the ineffable One produces Intellect, Soul, and eventually the visible, material world.²¹

It would seem that, for Simplicius, the planetary bodies are hypostases of the fixed sphere, a living being which incorporates without differentiation both the nature to move eastwards and the nature to move westwards.²² That he writes of procession and subordination (rather than reversion) serves, perhaps, to emphasize the decline in worth of the celestial bodies as one gets farther away from the sphere of the fixed stars.

COMMENT 10.13

IN DE CAELO 474.26–28

105n55

Planetary Eccentricity

In Ptolemy's *Almagest* (= *Syntaxis mathematica*), the 'distances' of the apogees and perigees of the planetary bodies are given in angular measure along the ecliptic from some reference point. Thus, for example, the Sun is said to have its apogee at 24;30° in advance of the summer solstice in *Alm.* 3.4. Moreover, each planetary eccentricity is reckoned as a ratio of the distance between the center of the planetary eccentric circle and the center of the zodiacal circle (where the observer is) to the radius of the eccentric circle, where this radius is assigned a value of 60 units.²³ So plainly, what Simplicius is ascribing here to the *Almagest* is not found in that treatise—barring the idea that the distance from the Earth to the Sun is constant [see 105n54]. In fact, it is in Ptolemy's *Hypotheses planetarum*, specifically, book 1, that these eccentricities are computed according to a nesting hypothesis to yield the maximum (*M*) and minimum (*m*) distances in Earth radii of each planet from the Earth, where $(M - m)/2$ is what Simplicius calls an eccentricity [see 105n55] and Figure 10.01, p. 181.

So, it is odd that Simplicius does not refer to the *Hypoth. plan.* here to make his point, especially given that he does allude later to book 2 of this treatise in his remarks on *De caelo* 2.12 [cf. 506.16–22]. Perhaps Simplicius

²¹ On the elements and sublunary change as treated in the *De caelo*, see Gill 2009. On procession (πρόοδος) and reversion (ἐπιστροφή), see A.C. Lloyd 1990, 98–122; Remes 2008, 35–75 (esp. 45–46, 51–52).

²² See 473.28–474.1 (the planets each have a nature that exists by procession), 487.4–10 with 487.15–488.1, 490.6–16 (the fixed sphere is productive and comprehensive of all motions).

²³ Cf. Heiberg 1898–1903, 1.233.18–22.

did not have the full text of the *Hypoth. plan.* before him but had access only to parts of it and some idea of its general program.

In this regard, Simplicius would be much in the same position as Proclus, one of the pre-eminent heads of the school of late Platonism in Athens,²⁴ the respected teacher²⁵ of Simplicius' teachers [see p. 3], and an authority whom Simplicius cites 32 times by name in his commentaries.²⁶ Proclus asserts in his commentary on Plato's *Timaeus* that Ptolemy did not really concern himself with planetary distances in the *Hypoth. plan.*²⁷ Still Proclus was aware of the mathematical details of the nesting of Mercury and Venus between the Moon and the Sun as presented in the *Hypoth. plan.* And, in light of what is proven in the *Almagest*, he does indicate²⁸ the sort of reasoning that might have led Ptolemy to this nesting hypothesis. Nevertheless, in *Hyp. ast.* 7.19–23, Proclus ascribes the nesting hypothesis to some unnamed astronomers rather than to Ptolemy. It would appear, then, that Proclus too lacked a complete text of the *Hypoth. plan.*,²⁹ though he did apparently know that it came in more than one book.³⁰

So, why does Simplicius ascribe the placement of the hypotheses for Venus and Mercury between the Sun and the Moon to Ptolemy and the *Almagest*? I suggest that Simplicius was aware that

an incredible numerical accident seemed to prove that the models for Mercury and Venus, as constructed in the *Almagest*, could be fitted into the space between moon and sun such that the maximum geocentric distance for the moon coincided with the minimum distance of Mercury, whose maximum distance would determine the minimum distance of Venus, which at its maximum distance would reach the solar orbit. [Neugebauer 1975, 917]

and that this is what moved him to speak of Ptolemy and the *Almagest* in this context. Moreover, I would suggest that, on this point at least, Proclus may have been his source. As I have already indicated, this information is offered by Proclus in his commentary on the *Timaeus*, and Proclus introduces the extreme values of the distances of the Moon, Mercury, Venus, and Sun (that

²⁴ 640.24–27: cf. Diels 1882–1895, 601.15–16, 611.11–12, 618.27, 675.4–5.

²⁵ For Proclus' epithet 'philosopher', see 643.27, 645.15 and 648.1: see also Diels 1882–1895, 611.11–12, 643.18, 795.4–5.

²⁶ On Simplicius' debt to Proclus, see Diels 1882–1895, 611.11–12, 795.4–5 and 12–14.

²⁷ Diehl 1903–1906, 3.62.22–24.

²⁸ Diehl 1903–1906, 3.62.24–63.20.

²⁹ Cf. Neugebauer 1975, 918–919.

³⁰ See Kroll 1899–1901, 2.230.14–15.

are found coincidentally in the *Hypoth. plan.*) as results that may be derived from what is proven in the *Almagest*.³¹

In short, Simplicius, who draws on Proclus' *In Plat. Tim.* later in his own commentary on the *De caelo*,³² may in this passage just be repeating Proclus' remarks in a compressed way. This would not preclude Simplicius' having access to (parts of) book 2 of the *Hypoth. plan.* either directly or through other sources.

COMMENT 10.14

IN DE CAELO 475.2–4

106n58

On Linear and Angular Speed

Simplicius appears to take Alexander's claim that the planets near the celestial sphere move more slowly to be a consequence of the thesis that the planetary periods are proportional to the distances of the planetary spheres from the center of the Earth. In attacking this thesis on the ground that it requires one to know the planetary distances from the Earth, Simplicius considers the fact that Alexander is effectively supposing that all the planets revolve with the same linear speed—that is, that they define arcs of equal lengths in equal times—since their angular speeds are inversely proportional to their distances measured from the Earth.³³ For, given that 30 years is a crude but standard value for the length of Saturn's sidereal period³⁴ and 30 days another common value for the length of the month, one might certainly think that the values obtain because both bodies move at the same linear speed or, equivalently because Saturn is 360 times as far from the Earth as the Moon. And this certainly makes sense of Simplicius' remark that Saturn would move at a faster linear speed than the Moon if its geocentric distance were more than 30 times the geocentric distance of the Moon and, thus, if their periods were *not* proportional to their distances from Earth.

Kepler in his *Mysterium cosmographicum*³⁵ cites *De caelo* 2.10 for the view that the speeds of the planets are proportional to their distances. To explain this he imputes to Aristotle the thesis that the movers of the planets impart

³¹ Diehl 1903–1906, 3.62.24–63.20.

³² Cf., e.g., 662.32–663.6, 663.27–664.4.

³³ Cf. 24.21–25.21 where bodies revolving at different distances from a center but sharing the same period (angular speed) are said to have different linear speeds. See also Vitruvius, *De arch.* 9.1.14–15.

³⁴ Cf., e.g., Geminus, *Intro. ast.* 1.24; Pliny, *Nat. hist.* 2.32; Cleomedes, *Cael.* 1.2.22–24.

³⁵ See Duncan and Aiton 1981, 197.

an equal (linear) motion to each, that is, 'each particle of Saturn is indeed as fast-moving as the lowest sphere of the Moon'. But, if the planets share the same linear speed, as Kepler suggests, it follows that they trace out equal arcs in equal times and, thus, that their angular speeds vary inversely with their distance from the Earth. The problem with this is twofold. First, if the angular speeds of the planets vary inversely with their distance from Earth, then these angular speeds do not vary directly with the distances of the planets from the fixed sphere. Hence, it is no longer true that the planet's motion, that is, the time it takes for it to go through its circuit, is proportional to its distance from the fixed sphere, as Aristotle plainly wishes to have it.³⁶ It is important to realize that in citing Aristotle's thesis that the motions of the planets vary as their distances, Kepler omits to define the point from which the distances are reckoned. Second, as 291a6–10 make clear, for Aristotle, the proportionality of the periods and distances is to be explained by reference to the influence of the motion of the sphere of the fixed stars, and there would thus seem to be little room for this in Kepler's account. Indeed, Kepler states that such influence is alien to his scheme.

In sum, we should not suppose that the planets are to have the same linear speed in *De caelo* 2.10.

107n62 COMMENT 10.15

IN DE CAELO 475.11–12

An Emendation

«διὰ τῆς τοῦ αὐτοῦ φορᾶς ἰούσης τε καὶ κρατουμένης» is the reading offered by the best mss of Simplicius' commentary and it is virtually the same as that found in the best mss of Plato's *Timaeus*. As Taylor rightly points out,³⁷ however, it is a very problematic reading: at 36c4–d1, Timaeus asserts that the undivided motion of the Same has been given dominance or power (κράτος) over the motion of the Different; but now, in the very process by which this power is exerted, the motion of the Same is putatively dominated. On the basis of the Latin translations of this passage by Cicero and Calcidius, Taylor suggests that the original text was probably «διὰ τῆς τοῦ αὐτοῦ φορᾶς ἰόντα τε καὶ κρατουμένην» (*scil.* «φόραν» at *Tim.* 38e6, i.e., 475.11). The idea is that the genitives «ἰούσης» and «κρατουμένης» have been obtained as the result of a false assimilation of the accusatives, «ἰόντα» and «κρατουμένην»,

³⁶ See Comment 10.01, p. 201.

³⁷ Taylor 1928, 202–203 *ad* 39a1.

to the case of «φορὰς» [*Tim.* 39a1, i.e., 475.12]. This is the reading found in Karsten's edition of Simplicius' commentary (Heiberg's c) and translated here.

An Emendation

Heiberg's text

ὥς διχόμηνον αὐτὴν ἐκάλεσεν Ἄρατος διὰ τὸ διχῇ τέμνειν τὸν μῆνα, καὶ τὰ ἄλλα
 συνεφώνει καὶ τὸ πλεονάκις μηνοειδῇ φαίνεσθαι

as Aratus called it *dichomēnos* because of its dividing the month into two, and
 the fact that [the Moon] often appears crescent-shaped particularly would be
 in accord [479.11–13]

will not do as it stands. His conjecture, «συνεφώνει καὶ τὸ» introduces an idiom of the form «καὶ τὰ ἄλλα ... καὶ τὸ X» meaning in this instance that 'X (= the fact that [the Moon] often appears crescent-shaped) particularly' would be in accord.¹ But this leaves open what is being accorded with and also renders problematic the remark at 479.13–14, 'and likewise gibbous'. After all, if the preceding sentence is particularly about the Moon's appearing crescent-shaped, what is the point of alluding to the Moon's being gibbous?

There are two possibilities. In his assessment of the relevant mss [see 1894, v], Heiberg affirms that A is primary. So, given that A reads «συνεφωνεῖτο», if one takes this as a starting point, the easiest emendation is «συνεφωνεῖτο (τῷ)», as proposed to me by R.B. Todd. The assumption here is that the final syllable of «συνεφωνεῖτο» was originally iterated in the semantically distinct but aurally identical form «τῷ» which was then subject to easy omission. Still, Heiberg also states that A is primary especially when it is supported by Moerbeke's translation. And, on this occasion, it turns out that Moerbeke's 'et alia consonant, scilicet sepe lunularem apparere' ('and the rest would be in agreement, that is, the fact that the Moon often appears crescent-shaped') supports the «συνεφώνει τὸ» which is found in a number of other mss, including two that Heiberg thinks very important.² So, if one

¹ On the idiom, see 244n56 below.

² Bossier n.d.b, 479.6–7. Moerbeke seems to assume that agreement or accord is with taking '*dichotomos*' to designate the Full Moon. Grosseteste's 'et alia consonuerunt eorum quae multotiens menoeidea apparere' [Bossier n.d.a, 152.7] appears to aim for a similar reading.

starts with this reading, the easy emendation is «συμφώνει (τῷ)». Either way, then, one avoids the difficulties of Heiberg's conjecture and the translation is the same.³

With the text so construed, the point is that taking 'dichotomos' to denote the Full Moon is consistent with Aristotle's remark that the Moon has a variety of waxing and waning crescents, presumably for the reason that the continuous change in the illumination of the lunar disk from waxing to waning crescents entails a phase of total illumination at mid-month. The same holds for the transition from its waxing to its waning gibbous phases.

117n48 COMMENT 11.02

IN DE CAELO 480.10–15

On Drum- or Lentil-Shaped Moons

Simplicius' account of the appearances of a Moon that has the shape of a drum or of a lentil is compressed. In the first place, it appears that the drum-shaped and lentil-shaped Moons are to be viewed so that the surface directly facing the observer is circular and flat in the case of the drum-shaped Moon; whereas in the case of the lentil-shaped Moon, it is circular with the bulge towards the observer. Obviously, it is true that neither the drum-shaped nor the lentil-shaped Moon will be visible at the beginning of the month. And given that the Moon rotates once in a synodic revolution,⁴ it will also be true that at mid-month both will have the same appearance as the Full Moon, that is, the observer will see a circular disk. When the drum-shaped and lentil-shaped Moons are not in syzygy, however, the circular surfaces are illuminated obliquely so that they will either be completely invisible [cf. 480.22–23] or visible completely in the case of the drum-shaped Moon, or visible to an extent in the case of the lentil-shaped Moon that is dependent on the height of its bulge. Simplicius thus makes clear that one can explain the phases of the Moon if it is spherical in shape but not if it is drum-shaped or lentil-shaped.

What one still needs, however, and what no one in antiquity attempts to provide so far as I am aware, is the further argument that the lunar phases can be explained *only* on the assumption of a spherical Moon. And perhaps this is understandable, since such argument might well prove circular: after

³ For the omission of «ἄν» in the apodosis of a present contrary-to-fact condition, see Smyth 1971, § 2358.b.

⁴ See Comment 11.05, p. 221.

all, consider the phases produced by a suitably spheroidal Moon. In truth, the observed lunar phases are not by themselves sufficient to establish that the Moon is a sphere.

Certainly, Aristotle does not attempt such an argument. Indeed, at *An. post.* 78b4–11 he writes:

Again, [consider] how they prove that the Moon is spherical from its increases—for if what increases in this way is spherical, and if the Moon increases [in this way], it is clear that [the Moon] is spherical. Accordingly, there is in this way a syllogism of the fact. But if the middle term is put the other way round, [there is a syllogism] of the reason why, since [the Moon] is not spherical because of its increases, but gets increases of this sort because of its being spherical.

Now syllogism of the fact that the Moon is spherical will succeed if and only if *whatever* shows such increases is indeed a sphere. As for syllogism of the reason why—to adapt the formulation Aristotle uses in regard to the planets which connects their not twinkling and their being near [*An. post.* 78a31–b4]—if it is given that being a sphere belongs to the Moon and that having such increases belongs to being a sphere, from this one may deduce that having such increases belongs to the Moon. (In the first syllogism, the middle term is ‘having such increases’; in the second, it is ‘being spherical’.) Clearly, syllogism of the reason why the Moon has such increases will succeed under the same condition as syllogism of the fact that it is spherical; that is, it will succeed if and only if a sphere produces such increases—which is patently not the case.⁵

COMMENT 11.03

IN DE CAELO 480.17–19 117n50

The Shape of Eclipsing Bodies

Compare *De caelo* 297b23–30, where the shifting boundary line of light and dark observed on the Moon during a lunar eclipse is the evidentiary basis for inferring the shape of the Earth:

Further, [the Earth’s shape is also known] through perceptual phenomena. For, [if it were not spherical,] eclipses of the Moon would not have the sorts of sections [that we see]. Certainly, as a matter of fact, [the Moon] receives all divisions in its monthly configurations, since it becomes straight and convex and concave. And in eclipses it always has the line delimiting [the shadow]

⁵ For discussion of Aristotle’s distinction here between syllogism of the fact and syllogism of the reason why, see Barnes 1975, 148–150.

convex, so that since [the Moon] is eclipsed because of the interposition of the Earth, the Earth's curvature (which is spherical) must be the cause of the [shadow's] shape.

As Neugebauer remarks, however,

It is an often repeated statement—from Aristotle to modern textbooks—that the sphericity of the earth is demonstrated by the fact that the earth's shadow on the Moon is always bounded by a convex arc. This, of course, is mathematically inconclusive, quite aside from the fact that nobody ever explains how to establish the accurate nature of the observed curve. But even if we take it for granted that the shadow of one object on another unknown surface appears as a circle one should remember that there exists an unlimited number of shadow casting and shadow receiving bodies which produce identical shadow limits. [Neugebauer 1975, 1093–1094]

A similar point would seem to hold for inferences about the shape of the Moon from the convex-appearance of the boundary of obscuration during solar eclipses. Indeed, if taken by itself, this argument from solar eclipses is hardly compelling, as Simplicius himself has shown inadvertently in drawing attention to the drum-shaped and lentil-shaped Moons, since these Moons are indistinguishable from a spherical Moon at opposition.

But, in any event, Simplicius has misconstrued the argument for the Moon's sphericity from solar eclipses [477.12–15, 480.16]. It is not in fact a *new* consideration but a further instance of the previous argument from the lunar phases, as Aristotle's Greek would suggest. And, as such, it suffers from a failure to demonstrate that *only* spherical bodies can produce the phenomena observed.

117n51 COMMENT 11.04

IN DE CAELO 480.19–21

On Flat or Convex Moons at Syzygy

This is wrong. As Simplicius has already indicated [480.10–11], there is no appreciable difference in the *apparent* shape of a spherical, a drum-shaped, and a lentil-shaped Moon at conjunction and opposition [see Figures 11.02–11.03, pp. 184–185]. So, given that

- whether it has shape of a sphere, a drum, or a lentil, the Moon will present a circular disk to the observer during conjunction and opposition,
- solar eclipses occur when the Moon is in conjunction, and
- it is the *edge* of the lunar disk that defines the boundary of light and dark (Simplicius' 'sections') seen during a solar eclipse,

then it follows that all three bodies will produce boundaries that appear the same on a given (spherical) object.

COMMENT 11.05

IN DE CAELO 480.21–23 117n52

Another Mistaken Argument

Simplicius is either forgetting that eclipses occur only when the Moon is in conjunction or opposition to the Sun, or that the drum-shaped and lentil-shaped Moons are oriented with their circular surfaces to the observer so that they are indistinguishable from the Full Moon when they are in opposition. In any case, any Moon-sized object placed in conjunction to the Sun will define an observable boundary of light and dark during a solar eclipse.

The rotation of the Moon is established Platonic doctrine.⁶ Simplicius accepts this and holds more generally that all celestial bodies rotate about internal axes.⁷ Aristotle [*De caelo* 2.8: cf. esp. 290a7–29], however, denies that the stars (fixed and planetary) either rotate or roll: for him, the Moon always shows the same face to us because it is fixed to a sphere that revolves about the Earth as its center.⁸

There is no precedent, so far as I know, for the hypothesis of a drum-shaped or of a lentil-shaped Moon. But, given that the Moon appears fully circular in opposition and that it rotates once in a synodic revolution, there are three basic classes of figure possible in that the Moon-shapes must have a circular surface that is either concave, flat, or convex. The drum-shaped Moon has a flat circular surface; the lentil-shaped Moon, a surface that is circular and mildly convex. So, if the hypotheses are Simplicius' own, the question is why he passes over the case of the Moon that has a concave circular surface and merely alludes to it in 480.19–21.

⁶ See Plato, *Tim.* 40a8: cf. Cleomedes, *Cael.* 2.4.1–9 (which ascribes recognition of this to Berossus).

⁷ See 454.23–456.27: cf. 32.13–33.16 with Comment 12.27, pp. 284–288.

⁸ Cf. Leggatt 1995, 240–241.

On ‘Fewer Motions Than Some’

Commentators have been troubled by the remark that the Sun and Moon have fewer motions than *some* planets because it does not seem to be true in the account of the homocentric spheres found in *Meta.* Λ.8. W.D. Ross¹ follows pseudo-Alexander [see 147n179] in proposing that Aristotle returns to Eudoxus’ theory that the Sun and the Moon each have three spheres, and thus understands Aristotle to hold that the Sun and the Moon have fewer motions than *any* of the other planets since these each have four spheres. To explain why Aristotle says that they have fewer motions than *some* of the planets, however, Ross argues that Aristotle is limiting himself to what is strictly sufficient to state the first ἀπορία. Hence, he writes ‘some’ rather than ‘any’.

H.J. Easterling² counters that Aristotle really does mean that the Sun and Moon have fewer motions than some of the planets, and proposes instead that Aristotle is thinking of a version of the homocentric theory in which the planetary systems in Eudoxus’ account are supplied with unwinding spheres. On this view, the Sun and the Moon do indeed perform fewer motions than some of the planets, since they each have fewer spheres than Jupiter, Mars, Venus, and Mercury but not Saturn. That is, if we follow Easterling and reckon the unwinding spheres with the planet whose motions they influence rather than with the planet whose spheres they unwind,³ the arrangement would be as in Table 12.01 [p. 224]. As Easterling remarks, this proposal entails that, prior to Callippus’ revision of the Eudoxan theory, Aristotle had already applied his unwinding spheres to the Eudoxan planetary systems; and, thus, that *Meta.* Λ.8 does not present a historical account of the development of homocentric theory.⁴

¹ Ross 1953, 2.394.

² Easterling 1961, 138–141.

³ Easterling 1961, 139n1. Cf. Elders 1966, 240 on *De caelo* 293a5–6.

⁴ But see Pellegrin and Dalimier 2004, 42–44.

Table 12.01. Easterling’s Conjecture

Planet	Winding Spheres	Unwinding Spheres	Total
Saturn	4	0	4
Jupiter	4	3	7
Mars	4	3	7
Mercury	4	3	7
Venus	4	3	7
Sun	3	3	6
Moon	3	2	5

D.R. Dicks, however, suggests that Aristotle is not thinking of homocentric spheres so much as of observable motions.⁵ Thus, for Dicks, Aristotle here recognizes that the Sun and the Moon do not exhibit retrogradation but has not yet seen that Mars and Venus do: as Dicks notes,⁶ in the original Eudoxan system, Mars and Venus do not go retrograde. The problem with this interpretation is its assumption that Aristotle and his contemporaries were aware of planetary stations and retrogradations.⁷

Still, Dicks may be pointing in the right direction. After all, it is possible that Aristotle is thinking of the planetary theory in Plato’s *Timaeus*.⁸ In this account, though all the planets have the motion of the Different, the Sun is apparently assigned this motion *simpliciter* and the other planets have powers that modify it. Thus, the Moon has a power that augments the motion of the Different; whereas Mars, Jupiter, and Saturn have powers that diminish it. Venus and Mercury, however, have powers that alternately increase and decrease the motion of the Different. In this sense, then, one might well say that the Sun and Moon perform fewer motions than *some* of the planets.

12In15 COMMENT 12.02

DE CAELO 292A3–6

Aristotle’s Occultation of Mars

Dave Herald of the International Occultation Timing Association has very kindly computed for me all the occultations of Mars by the Moon that were visible in Athens (37;35°N, 23;26°E) during Aristotle’s lifetime (–383 to –321).

⁵ Dicks 1970, 204–205; cf. Leggatt 1995, 246.
⁶ Dicks 1970, 187.
⁷ See Bowen 2001, 2002, and Comment 12.07, pp. 230–248.
⁸ See Comment 12.07, pp. 232–239.

He concludes that there are but two which fit Aristotle's report, those of –360 Mar 20 [see Figure 12.01, p. 186] and –356 May 4 [see Figure 2.02, p. 187]. Moreover, in his view, the first of these fits the report better than the second. According to Herald's computations, there was an occultation on –360 Mar 21 at 20;24 hr U(niversal) T(ime), that is, at 21;58 L(ocal) M(ean) T(ime), when the Moon was 34% illuminated, which lasted 64 minutes; and another, on –356 May 4 at 18;24 UT, that is, at 19;58 LMT, when the Moon was 44% illuminated, which lasted 13 minutes. The greatest source of uncertainty in these computations derives from the variation in the rate of the Earth's rotation, which at these times involves a correction of 5;08,24 hrs (with an uncertainty in the order of half an hour).

In light of these computations and of the fact that Aristotle spent much of his adult life in Athens, and granted that he actually saw the occultation, I would say that he may well be reporting one of these two occultations; and that, if so, I agree with Herald that it is more likely the occultation of –360 Mar 20 [see Figure 12.01, p. 186]. Clearly, the occultation of –356 is almost a complete miss for an observer at Athens [see Figure 12.02, p. 187]. F.R. Stephenson [2000], however, maintains that only the occultation of –356 May 4 was visible at Athens (which he locates at 37;58°N, 23;43°E). See Savoie 2003 for an excellent account of the difficulties in making such computations.

COMMENT 12.03

IN DE CAELO 481.12–15 121n17

Ancient Records of Occultations

According to Simplicius [117.24–27], the Egyptians kept written observations of the stars for at least 630,000 years and the Babylonians for 1,440,000 years; but this is sheer fantasy. As matters stand now, there does not seem to be any record in an Egyptian language of an interest in occultations. Fortunately, as the late Christopher Walker of the British Museum very kindly informed me, such an interest is amply attested in Mesopotamia by a Letter and Reports deriving from the royal archives at Nineveh that were formed during the eighth and seventh centuries BC. This Letter⁹ and the Reports¹⁰ specifically concern the Moon's occulting a planet (Jupiter or Saturn) or some fixed

⁹ See No. 84 in Parpola and Reade 1993.

¹⁰ See Hunger, Reade, and Parpola 1992, Nos. 30, 100, 166, 351, 351, 399, 408, 438, 443, 455, and 469.

star.¹¹ There is, so far as I am aware, no observational record in which some planet other than the Moon is said to occult another planet, though there are Letters¹² and Reports¹³ about planetary conjunctions.

The Diaries do not add much to this. The earliest record of an observation of an occultation in a Babylonian Diary is the entry for –277 VII 16¹⁴ and it concerns the Moon's occulting Jupiter. There are also Diary entries mentioning the conjunction of one planet with another for –567 III 1 and XII 12, –391 VIII 10, –380 XII 11, –346 IX 20, –333 III 26, –330 VII 2, –324 I 13 and VI 21, –322 VI 21 and XII 11, –321 I 27 [cf. II 2] and VI 23, 26.

It is interesting that Ptolemy reports several observations in Alexandria by Timocharis during the early third century BC of the Moon's occulting various fixed stars.¹⁵ Ptolemy also reports observations of Mars' and Jupiter's occulting different fixed stars in –271 and –240, respectively.¹⁶

One might suppose, in the light of what Aristotle and Simplicius say, that the early Greek interest in occultations derived from a concern to establish the order of the seven planets. But this is not necessarily what either Aristotle or Simplicius means to suggest: the immediate context is the claim that the Moon is the planet closest to the Earth and, like the observation of the Moon's occultation of Mars, the Egyptian and Babylonian reports may have been cited to buttress this point only. This would, of course, be consistent with the surviving Babylonian reports of occultations, which have a very different purpose.

122n22 COMMENT 12.04

IN DE CAELO 481.22–24

The Encouragement Offered

Mueller [2005, 22 and n61] assumes that Alexander and Simplicius are arguing about the use of «ἀποδέχεσθαι» ('to receive', *not* 'to attain') and «ἀπαι-

¹¹ Note that Reports Nos. 100 and 438 concern the occultation anticipated in Letter No. 84: cf. Parpola 1970–1983, 2.20.

¹² See Parpola and Reade 1993, Nos. 47 (with Parpola 1970–1983, 2.60–62), 63, 67 (with Parpola 1970–1983, 2.73–74), 340 (with Parpola 1970–1983, 2.260–261).

¹³ See Hunger, Reade, and Parpola 1992, Nos. 44, 48, 82, 212, 214, 244, 288, 350, 491.

¹⁴ See Sachs and Hunger 1989, 1.327: A26 + C5.

¹⁵ See Goldstein and Bowen 1991, Comment 1, Nos. 12–15 with § 2. Regarding Ptolemy's account of Timocharis' observation of Venus and η Vir, there is doubt that this should be read as an observation of an occultation: see Goldstein and Bowen 1991, Comment 1, No. 18 with § 3.

¹⁶ See Goldstein and Bowen 1991, Comment 1, Nos. 17 and 27.

τεῖν», but finds this hard to reconcile with Simplicius' remark at 481.26–30. If, however, we suppose that both Alexander and Simplicius read *De caelo* 292a14–17 as offering encouragement—«παράμυθεῖσθαι» may mean 'to exhort' (so Mueller), but it can also mean 'to encourage' or 'to reassure' [see 121n19]—then Alexander's point would be, I take it, that the encouragement (or reassurance) follows from the claim made at 292a17–18 that the problem is not beyond reason if one proceeds on the basis of certain starting points or arguments. In short, he would seem to think that proceeding is reasonable, but that the encouragement is still incomplete or lacking in that these starting points or arguments (which make proceeding reasonable) are not given here but in what follows. If this is right, Simplicius' objection is captious—he resents the suggestion that Aristotle ever expresses himself ἐλλειπτικῶς—and when he offers an interpretation that makes clear the flow of Aristotle's text, he effectively concedes Alexander's (very minor) point. Note the Latin version of the Hebrew translation of Themistius' paraphrase:

if we nevertheless move in thought from these things [about which we can get knowledge] to our inquiry by means of the following slight resources or principles, it will be neither unreasonable nor strange too that whatever [the facts] are, they should be found out in this way. [Landauer 1902, 119.30–33]

For another reading of these lines, see Rescigno 2004–2008, 289.

COMMENT 12.05

DE CAELO 292A18–21 122n25

The Heavenly Bodies Ensouled?

Ἄλλ' ἡμεῖς ὡς περὶ σωμάτων αὐτῶν μόνον, καὶ μονάδων τάξιν μὲν ἔχοντων, ἀψύχων δὲ πᾶμπαν, διανοοῦμεθα· δεῖ δ' ὡς μετεχόντων ὑπολαμβάνειν πράξεως καὶ ζωῆς
[292a18–21]

As Thomas Johansen [2009] has pointed out, there is ample evidence earlier in the *De caelo* that Aristotle regards the heavenly bodies as ensouled. Indeed, it would be difficult to explain the difference in the periods and directions of their motions if they were not, given that their material composition is the same and accounts only for the bare fact that their motion is circular by nature. Accordingly, some have set out to translate this passage in a way that avoids any indication of doubt about this on Aristotle's part.¹⁷ But such translations founder on the fact that Aristotle writes «ὡς μετεχόντων ...

¹⁷ See, e.g., Lennox 2009, 210.

ὕπολαμβάνειν», that in such cases «ὥς» with a participle typically indicates the thought of the subject of the main verb or of some other prominent subject in the sentence and *not* that of the speaker or writer of the sentence,¹⁸ and that «ὥς μετεχόντων» means ‘as if/though sharing’ or ‘in the belief that they share’, and the like.

To begin, Johansen’s claim that the occurrences of «ὥς» at 292a18, 20 are linguistically parallel is,¹⁹ I think, mistaken. At 292a18, the syntax spelled out is «ἀλλ’ ἡμεῖς (περὶ τούτων διανοούμεθα) ὥς περὶ σωμάτων ... διανοούμεθα», where «ὥς» is a comparative conjunction and means ‘as’ [cf. 482.6–9]. Many translators take this «ὥς» with «περὶ» and have ‘as if/though about’ but still seem to understand «περὶ τούτων» alone,²⁰ thus effectively construing «ὥς» as a coordinating conjunction, all the while translating it as a part of the subordinating complex «ὥς περὶ». Moreover, «ὕπολαμβάνειν» at 292a21 is intransitive—which is cumbersome in English, but note Moraux’s ‘se mettre dans l’esprit’²¹—and «ὥς μετεχόντων» is a genitive absolute (circumstantial) with «ὥς» serving adverbially.

Let us grant that Aristotle holds that the heavenly bodies are ensouled and is disinclined to treat them as mere units with position. The fact is that in these lines Aristotle is *now* speaking as one of a number of people who either do not believe the heavens are ensouled or who have for various reasons carried on as though they are not ensouled.²² It is *as a member of this group* that Aristotle voices the recommendation that they consider the heavenly bodies as though ensouled.

Nevertheless, in formulating his recommendation, Aristotle *does* bring to the fore the possibility that they are not ensouled. But does this constitute or entail doubt *on his part* that the heavenly bodies are ensouled? Obviously not, *in propria persona*. Even then, if it does—and I am not convinced of this, since neither logic nor grammar requires it—such doubt is inseparable from doubt that the ἀπορίαι can in fact be solved: as he makes clear, *if* we are to

¹⁸ See Smyth 1971, §§ 2086, 2996.

¹⁹ Johansen 2009, 22n22.

²⁰ Cf., e.g., Moraux 1965, 81; Mueller 2005, 22.

²¹ Moraux 1965, 81.

²² Elders [1966, 234] suggests that Aristotle has in mind Eudoxus’ treatment of the planets as purely geometrical units in *Meta.* A.8 [cf. Leggatt, 1995, 248] and thus construes the ‘we’ in question rather narrowly. As Simplicius’ paraphrase suggests, however, Aristotle may instead be thinking of a more general tendency to treat the heavenly bodies as though they were unit-points in figurate number [cf., e.g., Heath 1921, 1.76–84] when talking of the constellations formed by grouping these bodies into shapes, for example.

address the ἀπορία, then we *should* (or *must*) treat the heavenly bodies as living entities.²³ Accordingly, it is unnecessary to torture the Greek so that it reads in a way that is consistent with earlier indications that the heavenly bodies are living beings.

In sum, even when faithfully rendered, 292a18–21 does not suggest any real doubt on Aristotle's part that the heavenly bodies are ensouled.²⁴ It still remains true, of course, that Aristotle's discussion in 2.12 is tentative or provisional²⁵ but the reasons for this lie elsewhere.

COMMENT 12.06

IN DE CAELO 485.10–12 130n77

Fewer Motions: Better or Worse?

According to the Latin version of Themistius' paraphrase,²⁶ Alexander understood there to be two conflicting principles at work in Aristotle's argument:

- that what is nearer to the best obtains its perfection by a single action only, whereas things that are farther away will require more motions by as much as they are distant; and
- those things nearer the best pursue the best as an end with many actions, in the manner of the planets.²⁷

The Latin Themistius regards this as a misreading and proposes that there is really no contradiction.²⁸

Simplicius likewise cites Alexander but does not indicate any criticism on Alexander's part, unless «μήποτε δὲ καὶ τὸν δεύτερον μίγνυσι διορισμόν» hints at one. In any case, Simplicius rightly distinguishes Aristotle's argument that the other planets are superior to the Sun and Moon in that they perform more motions from his argument that the Sun and Moon are inferior because they perform fewer motions. For, while the five planets can attain the ultimate good through many motions, the Sun and Moon cannot attain

²³ For his part, Simplicius [482.9–10] affirms that there is no solution to the ἀπορία if we conceive of them as soulless point-magnitudes with position only.

²⁴ Cf. Comment 12.11, pp. 261–262.

²⁵ Cf. Bolton 2009, 64n19.

²⁶ Landauer 1902, 121.40–122.11 = fr. 158b in Rescigno 2004–2008, 2.290–291.

²⁷ Landauer 1902, 122.9 *plantae* (plants): 'planetæ' ('planets') would make better sense and is an easy emendation.

²⁸ Landauer 1902, 122.10–20, cf. 121.28–39.

this good in full measure but can only manage a few motions bringing them some good that is as near the ultimate good as they can reach.²⁹

134n107 COMMENT 12.07

IN DE CAELO 487.20–488.2

Awareness of Retrogradation

Simplicius' biographical reconstruction of the context of the first ἀπορία takes for granted that Aristotle was indeed aware of the fact that, unlike the Sun and Moon, the five planets make stations and retrogradations. This assumption, however, is not warranted by any evidence that has come down to us. Indeed, so far as one can tell given the evidence extant, it is an artifact of his manner of reading Plato and Aristotle, and derives from his interpretative agenda.

Still, the fundamental question is, 'When did Greek and Latin writers first undertake to explain the observed stations and retrogradations made by the five planets, and what can we say about the explanatory strategies adopted in this project during its earliest stages?'

If we are to identify the recognition of planetary retrogradation and, hence, of stations, it will be important to distinguish sorts of awareness of the planets. After all, it is one thing to suppose that the planets are wandering stars, that some stars (the Sun, Moon, and the five planets) do not maintain their position in relation to those stars which appear fixed in position. It is another to hold that all these wandering stars are left behind by the fixed stars and move in a direction opposite to the daily rotation of the celestial sphere, or even that this (direct) motion (eastwards) is in each case periodic. And it is yet another to suppose that some planets (specifically, Mercury, Venus, and the Sun) apparently overtake, and are overtaken by one another, or to extend this idea to Mars, Jupiter and Saturn as well. Still, none of this amounts to realizing that the five planets make stations and retrogradations.

Given the nature of the surviving evidence and that the present aim is to understand Simplicius, I will take a *via negativa* to the question of the awareness of the planetary station and retrogradation, and postpone study of just when and how such knowledge appears in Greek and Latin writers to

²⁹ Cf. 485.22–29, which contrasts the slight action of the celestial sphere and the slight action of the Sun and Moon, and 486.16–19, 486.26–487.3, 487.31–488.2. But see Mueller 2005, 24 and 26, nn77 and 84.

another occasion.³⁰ Accordingly, the present comment is intended to show that there is no good reason to hold that Greek or Latin writers prior to the late second century BC attempted to account for these planetary phases. To substantiate this conclusion, I will focus on five passages that scholars have taken to indicate knowledge of these planetary phenomena prior to the second century BC. My argument will not be that one cannot read these passages to entail such knowledge—obviously, one can—or that there are no other passages which scholars might interpret in this way. Rather, my burden, as I see it, is to establish a mode of argumentation by demonstrating that there is no need rooted in the five passages themselves that demands reading them in a way that presupposes awareness of planetary station and retrogradation. In some cases, this will follow because there is a number of possible readings and no sensible means of choosing between them; whereas, in others, it will follow because there are readings better suited to the documents in which the passage occurs. The upshot will, I trust, be the recognition that we should refrain from ascribing knowledge of these planetary phases until we find texts that actually require it in order to make sense of them. Thus, my aim is to discourage the elaboration and rationalization of ‘learned’ credulity by restoring some measure of sobriety deriving from a determination of what can actually be known to have been the case.

To frame this negative argument, we should bear in mind that there is simply no Greek or Latin terminology for, or mention of, the planetary phenomena of station and retrogradation until the latter parts of the first century BC. In other words, if you inspect the entire corpus of extant Greek and Latin documents—a task now feasible because much of this corpus is available today in electronic databases such as the *Thesaurus Linguae Graecae*—you will not find direct (datable) occurrences of words or expressions for these particular phenomena until the writings of Cicero, Diodorus Siculus, and Vitruvius.

Furthermore, two of these writers, Diodorus and Vitruvius, offer compelling evidence that the context in which the ideas of these planetary motions really became known to the Greeks and Romans was neither the tradition of Platonic and Aristotelian philosophy or cosmology (as Simplicius suggests) nor the quasi-indigenous Greek and Roman celestial science prior to the late second century BC. Rather, it was horoscopic astrology, a

³⁰ For some preliminary work on this, see Bowen 2012e and 2014.

discipline which is devoted to determining the fate of the native on the basis of the positions of the seven planetary bodies, and which first appears in the Greek and Roman worlds in Egypt in the very late second century BC, if not more recently.³¹ Thus, it would seem that the Greeks and Romans did not come to knowledge of the basic apparent motions of the planets through a formal or informal program of observation that was either inspired by philosophical concerns or viewed as a useful adjunct to these concerns. To the contrary, it now appears that their knowledge of these motions came by acquaintance at some level with the tabular literature used by astrologers to cast horoscopes.

Granted, this only shows that prior to the late second century BC the Greeks lacked a technical vocabulary for station and retrogradation, and that these phenomena were quite marginal to their thinking. It does not prove that they were utterly unaware of them, only that there is no ascertainable context in which it was important to speak of them clearly.

Plato, Timaeus 40c3–d3

Simplicius' remarks [488.18–24, 492.28–493.11] about the project of saving the planetary phenomena or appearances seem at odds with the epistemology and ontology found in those Platonic dialogues that do discuss astronomy, *Resp.* 6–7 and *Leg.* 7 in particular.

Thus, for instance, even though these dialogues do maintain distinctions between the real and the apparent, if the renowned image of the Divided Line in *Resp.* 6 means that the objects of scientific thought are the Forms themselves construed not as objects of direct inquiry but as starting points of demonstrations effectively interrelating these Forms, then there is no such thing as a scientific explanation of any phenomenon as such. That is, the planets and their motions are patently not Forms or what it is to be something, and so there is no scientific knowledge of them and no place for a program in astronomy to *explain* or even to save them, given that in this dialogue at least astronomy is a science. Moreover, at *Leg.* 821b3–822d1, the Athenian Stranger affirms against those who say that the planets never follow the same course—and so manifest no periodicity—that in reality the planets do not wander at all but that each moves instead constantly

³¹ See Bowen 2012e, 2014. The earliest extant horoscopes in Greek, Latin, and Demotic all derive from the latter parts of the first century BC: there are no references to horoscopic astrology in any Greco-Latin text dating from before this century.

on a single circle; and he rejects as blasphemy the practice of calling them wandering stars. His thesis that, though the planets may appear to move along many paths, they have only one proper motion, is directed against those who see no order or regularity at all in the planetary motions, to say nothing of recognizing that the planets make stations and retrogradations. In any case, the Athenian Stranger has not even distinguished the behavior of the Sun and Moon, which do not make stations and retrogradations, from that of the remaining planets, all of which do.

Nevertheless, there is one primary instance put forth by scholars, both ancient and modern, in which Plato is thought to write of the retrogradations and direct motions of the planets:

But, without seeing images of these same (gods), it would be a labor in vain to describe their dances and their coincidences (παραβολάς)³² with one another, the circling motions of their circuits back to themselves (τάς τῶν κύκλων πρὸς ἑαυτοὺς ἐπανακυκλήσεις), and their advances (προχωρήσεις), and which of the gods by entering conjunction (ἐν ταῖς συνάψεσιν) with one another as well as how many by entering opposition, and which by coming to be behind and in front of one another at which time intervals, are severally hidden to us and as they appear again send to those who cannot reckon, panics and signs of things that are going to happen afterwards. [*Tim.* 40c3–d3]

Their thesis is, in short, that these ἐπανακυκλήσεις and προχωρήσεις are respectively the planetary retrogradations and direct motions.³³

Now, by the close of the fourth century BC, it was indeed customary to distinguish two kinds of stars: those that are fixed in relation to one another and move only with the daily rotation of the heavens, and those that are not fixed (the Sun, Moon, Mercury, Venus, Mars, Jupiter, and Saturn) but move periodically in relation to the fixed stars in addition to their moving with the daily rotation [cf. 40b4–8]. However, one notable feature of how this distinction was made is the absence of any attempt to specify, or even to name, the ways in which the wandering stars or planets move in relation to the fixed stars. Moreover, the few explicit attempts to characterize the planets' observable motions are limited primarily to their sidereal motions, that is, to their return along the zodiacal circle to some star or constellation.

Thus, in the *Timaeus*, the seven planets are said to move on circles about the Earth, all in the plane of an oblique circle and in a direction opposite to

³² *Tim.* 40c4: see Comment 10.06, pp. 205–206.

³³ Documenting this view, which is dogma nowadays, would be a substantial task. For a recent occurrence, see Zeyl 2000, xlvii.

that of the daily rotation. Further, Mercury and Venus are, unlike the others planets, described as regularly overtaking and being overtaken by the Sun in the course of their circuits around this oblique course. So far this seems harmless enough. The difficulty is that, according to Timaeus, the dialogue's chief interlocutor, Mercury and Venus overtake and are overtaken by the Sun because, though they have been put into circles that have the same period as the Sun, each has been allotted a power or tendency contrary to the Sun [38d2–6].

As one might expect, this passage is important to those who hold that Timaeus' remarks about the planets show awareness of the fact that they sometimes exhibit retrograde motion. So, the question is, 'Need this contrary power entail a reference to, or knowledge of, retrogradation?' A.E. Taylor, for example, holds that the power in question is that exhibited by Mercury and Venus, the two inner planets, when their motion (which includes retrogradations) is viewed in relation to the Sun—meaning, I presume, that this power is evident in the observable fact that these planets, which never stray far from the Sun, rise before the Sun as morning stars and set after the Sun as evening stars.³⁴ Though Heath is agnostic about the meaning of the passage, he does maintain that the natural sense of the words is that Mercury and Venus actually move in the opposite direction to the Sun.³⁵ Though both scholars assume that Plato must have in mind station and retrogradation, it should be obvious that this is a *non sequitur*. The fact that Venus and Mercury appear as Evening and Morning Stars is, I admit, equivalent to the claim that Venus and Mercury exhibit retrograde motion.³⁶ But it is fallacious to impute knowledge of the latter to Plato (or to anyone for that matter) given only that he knows of the former. Indeed, as I shall argue, Plato's remarks about Venus and Mercury are easily understood without involving any allusion to planetary retrogradation.

Consider Timaeus' earlier description of the construction of the world-soul. The Demiurge begins by compounding soul stuff which he pounds out flat into a long band [35a1–b3]. Next, after marking the entire length of the band into sections according to the sequence 1, 2, 3, 4, 8, 9, 27, and after

³⁴ Taylor 1928, 196–202.

³⁵ Heath 1913, 165–169.

³⁶ Given that the Sun moves at a constant speed eastwards along the zodiacal circle, the fact that both Venus and Mercury, though they too have an overall eastward motion, sometimes cross our western horizon following the Sun (Evening Star) and then subsequently cross our eastern horizon in advance of it means that they have for a time made a westward motion or retrogradation.

inserting arithmetic and harmonic means and then filling in sections in the ratio of 4:3 with sections in the ratio of 9:8, he cuts the band lengthwise into two strips of equal length, lays one strip on the other to form an X, and joins the ends of each strip to produce two identical circles situated obliquely to one another and attached at diametrically opposing points [35b4–36c2]. Then,

he embraced (each strip) with a motion that goes round in the same place with regard to the same things, and made one circle the outer and the other the inner. Accordingly, the outer motion he declared to be characteristic of the nature of the Same; and the inner motion, characteristic of the nature of the Different. Then, he caused the [motion] of the Same to go round to the right on the side and the [motion] of the Different, to the left on the diagonal. And he gave supremacy to the revolution of the Same and the Like. For, he left it as one undivided [revolution]. But after he split the inner [revolution] six times into seven unequal circles according to each interval of doubles and triples, there being three of each [sequence], he prescribed that the circles go in directions opposite to one another, and that in speed three be similar whereas four be dissimilar to one another and to the three, though they move according to ratio. [Tim. 36c2–d7]

Timaeus does not explain how the circles taken from the Different can have motions in directions opposite to one another. Still, it is not difficult to supply one: all we need suppose is that Timaeus is alluding to the fact that circles into which the Different is divided have opposing motions, one due to the motion of the Same and the other due to the motion of the Different itself. In short, to leap ahead by talking of the bodies to be inserted in these seven circles, each will have a sidereal and a diurnal motion. The awkwardness here is due to the fact that, at this stage in Timaeus' tale, the world-soul has no body, which means that he is obliged to talk about motions (revolutions) without referring to what is moved or in motion.

For present purposes, there is a point which should be relatively uncontroversial; namely, that, in the logical sequence of Timaeus' account, the Demiurge's division of the motion or revolution of the Different into circular motions does not by itself produce motions that differ from one another. As the text makes clear, such differentiation among the motions or circles into which the Different is divided requires separate acts of prescription on the Demiurge's part [36d4–7].³⁷ But, given that the world-soul has as yet no body and is differentiated only by its motions, this act must effectively involve

³⁷ See Zeyl 2000, xlv–xlvi, 22.

assigning additional motions to the seven motions already established. One possible scheme would be to assign:

- the motion of the Different *simpliciter* to the Sun;
- the same speed to the motions of the Sun, Mercury, and Venus;
- an additional motion to each of Mars, Jupiter, and Saturn which constantly opposes (but does not overcome) the motion due the Different; and
- yet another motion to the Moon which constantly supplements the motion of the Different.³⁸

But, however it goes, the fundamental point is that Timaeus is accommodating the empirical fact that the planets each have fixed sidereal periods and that he proposes to do this by making these periods the outcome of *smooth* sidereal motions. Plainly, there is no recognition yet of the phenomena of station and retrogradation. Indeed, the story thus far is not even sufficient to account for motions of the Sun, Venus, and Mercury. To accomplish this, Timaeus first embodies these motions.

Thus, at 38c7–d1, the Demiurge constructs the body of each planet and places it into one of the seven revolutions into which the Different has been divided. In this way, the seven revolutions, which by themselves are neither paths nor tracks but simply motions, are embodied. And, though these revolutions were originally just portions of the world-soul, they now become the soul of a planet [cf. 38e3–6].

Next, at 38d2–6, to explain the known motions of the Sun, Venus, and Mercury, Timaeus relates that Mercury and Venus are each assigned a power (δύναμις) opposed to the Sun. This power is not itself a motion. Nor is it a power to move in a single direction, given that this power is to account for the observable fact that these planets overtake and are overtaken by the Sun. Rather, it is, I suggest, a power opposed to the Sun, specifically, to the smoothness or steadiness of its motion eastward. That is, it is a feature enabling Mercury and Venus to slow down and speed up in relation to the Sun's constant motion as all three course eastward. The only constraint is that the exercise of this power must be such that the periods of the eastward circuits are the same for all three. In effect, Timaeus assigns the soul of Mercury and of Venus, treated now as living creatures, an ability to move autonomously and intermittently with a motion that augments and diminishes the revolution of the Different.³⁹

³⁸ Cf. Cornford 1966, 74–86.

³⁹ Cf. *Epin.* 986e3–7, 987b2–5.

But what might Timaeus hope to accomplish in this? Is he allowing for the fact that Venus and Mercury never stray far from the Sun and are visible only for a brief while after sunset or before sunrise? Or does he really understand that Mercury and Venus both exhibit stations and retrogradations? Clearly, the proposition that Venus and Mercury are both morning and evening stars and the proposition that they both make periodic stations and retrogradations are as a matter of physical fact equivalent. Equally clear is the fallacy of supposing that being aware of one of these two equivalent propositions entails being aware of the other. So, which of them might Timaeus have in mind? As it turns out, what he actually says offers virtually no support for the view that he is thinking of the stations and retrogradations that Mercury and Venus regularly make.

To explain: for better or worse, Timaeus is treating the observable motions of Venus and Mercury as real motions rather than as apparent motions to be explained away. The metaphor that he uses in assigning to each planet a power to vary its motion eastward is that of a circular race. Mercury and Venus are, in effect, imagined as runners who, though they keep pace with the Sun overall and complete the eastward circuit in the same time, occasionally fall behind, then catch up to, and even overtake the Sun before slowing down and falling back again. It is important to realize that there is nothing in this metaphor involving, requiring, or implying that Mercury and Venus make stations and retrogradations against the background of the fixed stars. Such reference to the fixed stars in talking of station and retrogradation would, of course, be diagnostic. But in its absence, we must conclude that Timaeus' imagery no more entails that Mercury and Venus make stations and retrogradations than, for instance, falling behind in a race and then catching up and going ahead entails really stopping, going backwards, stopping, and then racing forwards, or even appearing to do any of these things against some background of stationary spectators. Indeed, it is telling that Timaeus does not even require that the exercise of this contrary power be regular or periodic like the planet's sidereal motion. All that the passage demands is a sense of the overall eastward direction of the race; and this itself may well have been inferred from the fact that the planets set close to the Sun, the eastward motion of which is readily inferred from its observable behavior at the horizon. Accordingly, there is no warrant here to suppose that Timaeus is accommodating any knowledge of planetary station and retrogradation.

This brings us back to *Tim.* 40c3–d3 and the problem of deciding what the ἐπανακυκλήσεις and προχωρήσεις are. If we construe the planetary ἐπανακυκλήσεις as the planetary circlings back or goings round—the full locution,

‘the circling motions of their circuits back to themselves’, is typically pleonastic—the question is whether these ‘circlings back’ include their diurnal motions, their sidereal motions, or both. How one answers this will bear in turn on whether «καί» in «καὶ προχωρήσεις» [40c5] is construed as epexegetical: the προχωρήσεις themselves would seem to be the planetary motions eastward.⁴⁰

In any case, nothing Timaeus says warrants taking «ἐπανακυκλήσεις» to designate retrogradations. For, up to the point where he turns to the matter of planetary omens, Timaeus’ remarks are made of all seven planets without qualification or distinction. Thus, if one insists that Timaeus is referring to retrogradations, one effectively introjects, and then has to mitigate, the acute problem that this makes his reference to ἐπανακυκλήσεις deceptive and half true if not plainly false, because neither the Sun nor the Moon exhibits retrograde motion. One may, of course, do this by further supposing a compression in the way that Timaeus expresses himself. But this is a desperate interpretative strategy, given the availability of alternatives that do less violence to the text. And there are a number of credible alternatives that readily come to mind. For example, if we suppose instead that each planet has more than one ἐπανακύκλησις, these might well include:

- its diurnal circling back due to the revolution of the Same
- its sidereal circling back due to the revolution of the Different as modified by its own native power (in the case of Mercury and Venus) or by the motion that it contributes in addition (in the case of the Moon) or in opposition (in the case of Mars, Jupiter, and Saturn), as well as
- the resultant spiral.

Or if we imagine that each planet has only one ἐπανακύκλησις, it would still be acceptable to identify it as any one of these possibilities. And in no case would this yield any problems with the text.

⁴⁰ There is no compelling reason in the *Timaeus* for sharply distinguishing an ἐπανακύκλησις from an ἀνακύκλησις. The participial form of the verb «ἀνακυκλεῖσθαι» and the cognate «ἀνακύκλησις» each occur once in the Platonic corpus. Plato, *Pol.* 269e3 mentions an ἀνακύκλησις of the cosmos. In context, this is plainly a rotation in the opposite direction [cf. 269a1–5, c4–d4]. Specifically, it is a (periodic) reversal in direction of the diurnal rotation (currently from east to west, but earlier, so the story goes, from west to east). The participial form occurs at *Tim.* 37a5. Here «αὐτὴ τε ἀνακυκλουμένη πρὸς αὐτήν», however, can mean at most ‘it circling back to itself’ without implying any specific direction, since the motion at issue is that of the world-soul understood as a mixture of the Same and the Different.

The noun «ἐπανακύκλησις» is rare: it occurs once in the Platonic corpus and not again until the Platonic commentators writing almost a millennium later. So, it is admittedly difficult to get a sure sense of its meaning in the *Timaeus*. The related verb «ἐπανακυκλείσθαι» occurs slightly more often, though, again, only once in the Platonic corpus. There are several undatable passages in the Homeric scholia in which the verb means ‘to circle back’. The earliest datable occurrences are in texts written in the second century AD. In general, the verb as it appears in these and later documents means ‘to circle back’, ‘to recur’, ‘to recur cyclically’, ‘to move or go in a circle’, and the like. Still, we should perhaps inquire whether the use of this verb at *Resp.* 617b2 illuminates the meaning of the cognate noun in the *Timaeus* or itself indicates retrograde motion.

Plato, Resp. 617a4–b4

In relating what is now known as the Myth of Er, Socrates remarks:

The spindle turns as whole, then, in a circle with the same motion; but in the whole as it revolves, the seven inner circles revolve gently with a motion that is opposite to the whole. And of these circles, the eighth⁴¹ goes most swiftly. Second and together with one another go the seventh, sixth, and fifth [circles].⁴² Third in motion, as it appears to them, goes the fourth [circle]⁴³ circling back (ἐπανακυκλούμενον). And fourth goes the third;⁴⁴ and fifth, the second.⁴⁵ [Resp. 617a4–b4]

It will be agreed on all sides, I expect, that this observed motion of Mars is not retrograde; that is, it is not a motion westward taking place between two stations. Given the mechanism governing planetary motion that is described in the Myth of Er, this observed motion can only be Mars’ unabated motion eastward. So, the participle «ἐπανακυκλούμενον» signifies here no more than ‘going-back in a circle’, not a counter-revolution. And so it fits with later usage and is consistent with the account of *Tim.* 40c3–d3 suggested above.

⁴¹ *scil.* the circle of the Moon.

⁴² *scil.* the circles of the Sun, Venus, and Mercury.

⁴³ *scil.* the circle of Mars.

⁴⁴ *scil.* the circle of Jupiter.

⁴⁵ *scil.* the circle of Saturn.

The Planetary Turnings

There are occasions in which Plato writes of planetary τροπαί. At *Pol.* 270b10–c2, we read:

One should regard this change as the greatest and most complete τροπή of all the τροπαί that occur in the heavens.

This greatest and most complete τροπή is the turning round or reversal in direction of the daily rotation of the cosmos [cf. *Pol.* 269a1–5, c4–d4]. At *Leg.* 767c6, 945e4, for instance, we find the more common use of «τροπαί» to designate the reversals in the direction of the Sun's motion as observed along the horizon as well as those points on the horizon where these reversals are seen to take place. Specifically, it designates these turnings and the two points on the eastern horizon where the Sun rises on days of solstice.

Now, one might be tempted to imagine that other planets were also thought to have such τροπαί as well, that Greeks at the time were aware that during its sidereal period each planet will rise at a northernmost and a southernmost point on the eastern horizon. The main problem is that there is no independent record or indication that any ancient Greek actually observed or was concerned with the lunar standstills, for example, or with the behavior of the planets as observed at the horizon. Still, it certainly remains a possibility, even if the idea was not fully articulated or realized in action. Admittedly, this idea *may* be in play when Timaeus, in speaking of the Sun, Moon, and five planets, states:

In this way and for the sake of these [reasons] were generated all those heavenly bodies which, as they make their way through the heavens, have τροπαί, in order that this [living thing] should be as like as possible to the complete and intelligible Living Thing in the imitation of its sempiternal nature.
[*Tim.* 39d7–e2: cf. 38c3–6]

Such talk of τροπαί, even if it denotes not turnings or revolutions but reversals or goings back(ward), still does not amount to recognition of planetary retrogradation. After all, when the turnings are not reversals in the motion of the cosmos itself, that is, its counterrevolutions, they are planetary reversals in direction and points on the horizon where these reversals are observed to occur. Moreover, even if Plato is thinking that each planet has τροπαί of this sort at 39d7–e2, such reversals are simply artifacts of the fact that all seven bodies move on circles oblique to the daily rotation. In other words, the reversal indicated is *not* the reversal meant when the ancients actually do talk of a planet's retrograde motion—as the fact that Plato makes no mention of stations or of the fixed stars, and that he includes the Sun and Moon with the five planets would indicate.

Epinomis 986a8–987d2

Though the *Epinomis* is a dialogue purporting to continue the conversation represented in Plato's *Leges* and was for a long time included in the Platonic corpus, the consensus now is that it was not in fact written by Plato. There is an ancient tradition that it was written instead by Philip of Opus (*flor.* ca –350), a contemporary of Aristotle, in the period after Plato's death in –346.

During this conversation, the Athenian Stranger has occasion to emphasize that there are eight visible gods in the heavens, each equally deserving of honor and devotion. This requires him to state who these gods are [986a8–987d2] and, thus, he comes to declare:

But they have in fact taken their nomenclature from gods. For, the Morning Star, which is also the Evening Star, has itself the credit, I dare say, of belonging to Aphrodite, which is very fitting for a Syrian Lawgiver; whereas the [planet] that roughly keeps pace with the Sun and at the same time with this [first one] belongs to Hermes.

We should mention three further motions of [bodies] that make their way to the right with the Moon and Sun. And we must say that the eighth is one which one should call Cosmos in a special sense, and which makes its way in opposition to all the others as it carries [round] the rest, as it would seem even to men who know little of these matters. But we must state, and do state, all that we know sufficiently, since real wisdom appears in this way somehow to one who has shared even slightly in right and divine thought.

Three [wandering] stars are left then, of which there is one that differs among them by its slowness, and some speak of it by the name of Saturn; but we must say that the one after this in slowness belongs to Jupiter; and the [planet] after this belongs to Mars—it has the reddest color of all.

It is not at all difficult to understand any of this, when someone points it out; but, as we say, it is necessary that he who has learned take the lead.

[*Epin.* 987b1–d2]

As this passage makes clear, *Epin.* 986a8–987d2 concerns only the sidereal motion of each planet: that motion by which each planet returns to a fixed star serves by itself to distinguish the seven wandering stars from those that are fixed.

Epicurus, Epistula ad Pythoclem

In book 10 of his *Vitae philosophorum*, Diogenes Laertius (third century AD) preserves three letters from Epicurus (–340 to –269) to various correspondents. Of particular interest is the letter to Pythocles in which Epicurus undertakes a 'brief, well circumscribed discussion of phenomena in the

sky'.⁴⁶ The basic aim in this discussion is to attain peace of mind and sure confidence. As Epicurus would have it, this aim is to be realized by noting that each of these phenomena admits of more than one explanation and by refusing to make arbitrary choices among the alternatives.⁴⁷

Thus, near the end of his letter, Epicurus gives two accounts of why some stars are fixed and others wander. To begin, he entertains the three possible explanations of why some stars seem fixed:⁴⁸

- they are in a part of the cosmos that is at rest, or
- they are enveloped in a revolving ring of air that checks their motion, or
- their fuel supply is not elongated—which means that they are observed only in one place.

Then, he turns to the wandering stars. As he sees it,

it is possible that some of the stars wander—if it happens that they are subject to motions in this way—and that others may not in fact because, as they move in a circle, they have been so constrained from the beginning that some move along the same revolution which is smooth, whereas others (move) at the same time (along a revolution) which is subject to certain unsmoothnesses. But it is also possible that in the regions where they travel there are in some places smooth stretches of air that push them on together in the same direction successively and kindle them smoothly, whereas in other places the [stretches] are so unsmooth that the variations observed are produced.

[von der Muehll 1922, 41.20–42.5]

Epicurus begins by registering doubt that there really are stars that wander. He then explains the distinction between fixed and wandering stars first by imagining that it has been ordained from the beginning that each star moves in a circle, and that the revolution in this circle is sometimes smooth and sometimes unsmooth. Alternatively, he supposes that each star is produced by kindling air⁴⁹ and that some stars seem fixed because the airy fuel for them is configured smoothly whereas other stars appear to wander because their fuel is configured unsmoothly.

Now, the smooth or regular revolution has to be the diurnal revolution of the fixed stars. But what makes the other revolutions unsmooth or irregular? There are many possible answers. After all, revolutions may be unsmooth if they define unequal arcs in equal times, these arcs being either always in the

⁴⁶ von der Muehll 1922, 27.13–28.

⁴⁷ von der Muehll 1922, 28.7–29.6.

⁴⁸ von der Muehll 1922, 41.12–18.

⁴⁹ Cf. von der Muehll 1922, 31.6–10.

same direction or sometimes in one direction and sometimes in the other. They may also be unsmooth if they may make occasional departures from the circle, or if they combine the two preceding types of unsmoothness. In short, Epicurus' account is severely underdetermined on this point because he neither states which of the numerous sorts of unsmoothness he has in mind nor describes how the air that is the fuel for the planets is configured. Thus far, then, it would not appear that Epicurus is thinking of anything so specific as planetary station and retrogradation.

Next, Epicurus inveighs briefly against the partisans of rash astronomy who maintain that there is but a single cause for the fact that some stars wander while the others stay fixed.⁵⁰ Then, he turns to the observation that some planets seem to fall behind others during the course of their revolution:

It happens that some stars are observed being left behind by others because, though they travel the same circle, they go round more slowly; because, though they are drawn back by the same revolution, they go in the opposite direction, and also because, though [all] circle round the same revolution, some go round through a greater region and some through a lesser. But speaking of these matters without qualification is fitting to those who wish to talk marvels to the many. [von der Muehl 1922, 42.10–16]

In other words, to account for their wandering, he turns to the fact that the planets have different (sidereal) periods. He offers three ways to account for this. The first is that the planets all go round the same circle (westwards) but at different speeds, and thus they (only) appear to move eastwards at different rates.⁵¹ Next is that the planets that seem slower are really going in the opposite direction to those that appear faster but nevertheless do go in the same direction overall because they are dragged round by the (stronger) revolution of the latter.⁵² The third explanation is wonderfully vague. The problem is the pleonastic «τὴν αὐτὴν δίνην περικυκλοῦντα» ('circle round the same revolution' = 'perform the same revolution') and deciding what makes a revolution the same. There are several possibilities, though the one that seems most promising is that the planets each move eastward (same direction)⁵³ with the same *linear* speed.⁵⁴ This interpretation amounts

⁵⁰ von der Muehl 1922, 42.5–9.

⁵¹ Simplicius [476.11–12] explicitly rejects this line of argument: see 109n73.

⁵² This may be no more than a creative extrapolation of the claim in Aristotle, *De caelo* 2.10 that the revolution of the celestial sphere reduces the eastward motion of the planets.

⁵³ If the direction is westward, this third account collapses into the first.

⁵⁴ If they had the same *angular* speed, they would have the same sidereal period, that is, they would not fall behind one another.

to the sort of account considered by Simplicius in commenting on *De caelo* 2.10.⁵⁵ in that it explains the varying planetary sidereal periods as a result of the fact that the planetary revolutions are of different sizes.

Ptolemy, Alm. 12.1: Apollonius of Perga

In the first chapter of book 12 of his *Almagest*, Ptolemy turns his attention to the retrograde arcs described by each of the five planets on the celestial sphere as it travels from first to second station [see Figure 6, p. 25]. Since the lengths of these arcs vary periodically in each case, he sets himself the task of determining the least and greatest arcs for each planet, and of showing that his computations of the lengths of these arcs are in as close agreement as possible with the observed data. He begins by noting that, “for this sort of determination, both other μαθηματικοί and Apollonius of Perga⁵⁶ prove in the case of a single anomaly of the Sun the lemma⁵⁷ that ...”,⁵⁸ where this lemma lays out conditions for determining the stationary points in an epicyclic and in an eccentric hypothesis. Then, in the rest of the chapter, Ptolemy presents his own mathematical derivation of the stationary points, which unlike any previous effort, combines both hypotheses in a single display or figure.⁵⁹ The problem is to decide whether any of this entitles us to suppose that Apollonius was aware that the five planets make stations and retrogradations.

Scholars commonly suppose that Ptolemy’s proof of what ‘the other μαθηματικοί and Apollonius of Perga’ have demonstrated goes back to Apollonius.

⁵⁵ 474.29–475.9: see Comment 10.14, pp. 213–214.

⁵⁶ οἱ τε ἄλλοι μαθηματικοὶ καὶ Ἀπολλώνιος ὁ Περγαῖος. Gerald Toomer [1984, 555] has ‘a number of mathematicians, notably Apollonius of Perge’. The locution, «οἱ τε ἄλλοι καὶ X» (‘the others and X’ or ‘X, besides others’), occurs fairly often in Greek. In general, it serves to single out X as a member of a group [cf. Comment 11.01, p. 217–218]. Whether this should be rendered along the lines of ‘the others and especially X’ as a rule seems unlikely, given the number of occurrences in which ‘X’ is modified by some intensive pronominal adjective or in which an adverb such as «μάλιστα» (‘especially’) is added in order to achieve this sort of emphasis. In the same vein, we should not allow that the true subject of the locution is X alone, that mention of others is perhaps merely a mark of politeness and urbanity or the like. This may turn out to be true when what follows includes an attribution directed explicitly to X—though even here one should prefer to see argument case by case rather than a mere stipulation of what the locution means—but it seems unlikely when, as we find in the present instance, the others are explicitly described by an adjective or the like and nothing extra is added about X. The practical point is that Apollonius may here be singled out not as a special contributor but as one that defines the type, that is, the μαθηματικός.

⁵⁷ 2.450.9 προαποδεικνύουσι (prove the lemma): lit. ‘prove before or in advance’.

⁵⁸ Heiberg 1898–1903, 2.450.9–11.

⁵⁹ Heiberg 1898–1903, 2.451.22–452.4.

But this is obviously incorrect: Ptolemy in fact presents the proof that he gives in *Alm.* 12.1 as his own and opposes it to the pair of proofs offered by the earlier theorists.⁶⁰ So, what is the relation of Ptolemy's contribution to that of his predecessors in this matter? There is, of course, no way to discern how the work of the other μαθηματικοί figures in Ptolemy's proof. As for Apollonius, Neugebauer has pointed out that there are important relations between Ptolemy's proof and certain theorems in Apollonius' *Conica* and *Plan. loci*.⁶¹ But none of this tells us about what Apollonius and the other μαθηματικοί were doing. Though Ptolemy plainly supposes that the lemma was proven for the sort of determination that he has in mind,⁶² the truth may be that he is in fact adapting arguments propounded originally in other contexts to his own purposes without recognizing these other contexts.

This feature of Ptolemy's historiography comes into play later when he introduces a lemma about scalene triangles which he attributes explicitly to Apollonius:

Let us accept these preliminary results considered thus far. Given that it remains to prove that, when the straight lines divided in this sort of ratio have been ascertained for each of the two hypotheses, the points *H* and *Θ* will encompass the appearances of the stations, and that the arc *HΦΘ* must be retrograde, while the rest [of the circle] must be direct, Apollonius assumes in advance a small lemma, namely, that, given the triangle *ABΓ* which has *BΓ* longer than *ΑΓ*, if *ΓΔ*, which is not less than *ΑΓ*, is taken [from *ΓΒ*], *ΓΔ* to *ΒΔ* will have a ratio greater than the angle subtended by *ABΓ* to the angle subtended by *ΒΓΑ*.
[Heiberg 1898–1903, 2.456.3–13]

This lemma itself is purely mathematical and bears no indication of its original context or purpose. Granted, for his part, Ptolemy presents the lemma as intended for the next step in his own proof, a single proof identifying the stationary points in both astronomical hypotheses. But in doing this, Ptolemy effectively contradicts his earlier claim that this unified proof is his. Thus, taking this passage as evidence that Apollonius was in fact aware of stations and retrogradations would seem unwarranted. Indeed, it makes better sense to hold that, in borrowing this lemma from Apollonius, Ptolemy has conflated the reasons why Apollonius proposed it with the reasons why he

⁶⁰ As Toomer [1984, 556n3] rightly remarks, this weighs against Neugebauer's view [1975, 264; cf. 1955] that Ptolemy's proof is taken from Apollonius.

⁶¹ Neugebauer 1959b, 1975, 264.

⁶² Though «εἰς δὴ τὴν τοιαύτην διάληψιν» may indicate respect, it probably indicates purpose here, as Toomer has it [1984, 555; cf. Heiberg 1898–1903, 2.456.3–10].

borrowed it. This is not, I hasten to add, a great blunder on Ptolemy's part: the *Almagest* is witness to his active engagement with astronomical problems; there is no basis for any expectation of concern with their prior history. The *Almagest* is a treatise in astronomy and not in the history of astronomy. His assumption that Apollonius was working on the same problems as he is perfectly rational and akin to Hipparchus' tacitly 'modernizing' the accounts of the heavens put forward by Eudoxus and Aratus.⁶³ The problems come when modern historians fail to see this.

In sum, Ptolemy himself gives reason to doubt that Apollonius himself undertook a demonstration of planetary stationary points and retrograde arcs. To this argument from what Ptolemy actually says should be added the numerous considerations adduced by Goldstein [2009] in his own examination of Apollonius' purported contribution to ancient astronomy.

At the same time, it is, I admit, reasonable to ask whether Apollonius did address the issue of the planetary stations. After all, his skill as a mathematician is amply evident and the problem is a real one for any theorist disposed to a kinematic, geometric representation of planetary motion that gives priority to circular motion. Further, it is well within the realm of possibility that Apollonius learned of the planetary motions from sources that were ultimately Babylonian—there was certainly an influx of Babylonian celestial science in the century or so after the fall of Babylon to Alexander in –330, as P. Hibeh 27 attests, and planetary theory is found in many divisions of this science. Still, to those who would adopt this line of speculation, it should be clear that, so far as one can tell in light of the evidence currently available, any work by Apollonius in planetary theory was marginal to Greco-Latin interests in celestial science over the next two or three centuries: there is, after all, no evidence of any further commentary on this problem of stationary points in the Greco-Latin astronomical literature extant until the time of Ptolemy, even in instances in which such commentary or acknowledgment would have been appropriate.⁶⁴ But, more fundamentally, one must acknowledge that speculation of this sort, though useful perhaps for generating hypotheses for research, does not constitute historical knowledge and has no place among the positive results confirmable by recourse to the documentary remains. To the contrary, so far as Apollonius is concerned,

⁶³ See Bowen and Goldstein 1991.

⁶⁴ Likewise, as Goldstein [2009] points out, the same is true of Apollonius' putative demonstration of the equivalence of the eccentric and epicyclic hypotheses.

the sober claim that he merely supplied some fundamental results in planar geometry is alone cogent, since this is all that *Alm.* 12.1 demands.⁶⁵

Conclusion

Neither the Platonic nor the pseudepigraphic Platonic dialogues provide good support for the thesis that the Greeks prior to the first century BC were aware of planetary stations and retrogradations. The same holds true of Epicurus' letters and of what Ptolemy actually reports of his early predecessors, Apollonius in particular. Indeed, these passages at issue require much less—in the main, a recognition of the varying sidereal motions that the planets have.

Given that, excluding the disputed *Meta.* Λ.8, Aristotle himself does not betray knowledge of these planetary phenomena, there is no warrant *prima facie* for the claim that Aristotle actually had such knowledge or that it figures in *Meta.* Λ.8. Accordingly, it follows that Simplicius' reconstruction of Aristotle's formulation of the two ἀπορίαι may well be mistaken. Recognizing this has important consequences. Notably, it allows us to put aside scholarly accounts that take for granted that Simplicius is correct. Specifically, it allows us to disengage the current study of Simplicius' commentary on *In de caelo* 2.10–12 from the corpus of learned speculation that reconstructs the homocentric theory of planetary motion described in Λ.8 by correcting the technical details of Simplicius' account [492.25–499.15]⁶⁶ and then teasing out the mathematical implications of this significantly 'revised' Simplicius. In short, we are, for now at least, spared the farrago of mathematical and historical analysis that has its roots in the work of Giovanni Schiaparelli [1925–1927] and set free to examine how Simplicius reconstructs the past in order to meet Philoponus' attack.

Should one balk at this and wonder whether it is right to sidestep Schiaparelli and his intellectual epigony in this way, I will point out that Aristotle's account is so focused on its immediate task, counting the number of unmoved movers, that it omits:

- naming the planetary motions in question,
- explaining what the third and fourth motions of the five planets are for,

⁶⁵ As Goldstein [2009] observes, it is unusual for Ptolemy to attribute theorems to named predecessors, that one or both of the references to 'Ἀπολλώνιος in 12.1 may be an interpolation, and that either of these references may derive from an early misreading of «'Ἀπολλινάριος».

⁶⁶ See Comments 12.12, 12.16, pp. 262–264, 265–266.

- stating where the planetary body lies on the sphere in which it is embedded,
- describing how these spheres together account for the observed planetary motion,
- identifying what Callippus' additional spheres actually accomplished,
- revising the planetary hypotheses that are incorporated into the single cosmic structure, and
- explaining where the unwinding spheres belong or how they actually work.

In other words, the account in Λ .8 is grossly underdetermined from the standpoint of astronomy, and reasonably so. Moreover, though a modest amount of what is missing may be inferred plausibly from what Aristotle writes, most of it cannot but requires introducing assumptions and using mathematics to make inferences that are at best consistent with the text. But this latter kind of argument is fallacious because it imputes to Aristotle some consequences of what he has written. Granted, this fallacy *might* be mitigated somewhat by finding what is imputed in his writings elsewhere or in those of his contemporaries. But as I have tried to show in this Comment, the bar for such mitigation is high. In truth, unless new texts come to light from the period, I would say that this mitigation is simply not forthcoming, at least for those who choose not to ignore a plainer meaning of what Aristotle and his contemporaries have actually written elsewhere in favor of an interpretation whose main, if not only, justification is that it somehow 'saves' *Meta.* Λ .8. In my view, *any* such reconstruction that introduces phenomena demonstrably unnoticed at the time neither constitutes nor advances knowledge of the past. In fact, such scholarship simply demonstrates that we can go very far astray indeed when we ask the wrong questions of a text.

136n118 COMMENT 12.08

IN DE CAELO 488.20

Proclus on Sosigenes

It is customary to cite Proclus, *Hyp. ast.* 4.98 in support of the claim that Sosigenes wrote a treatise entitled *On the Unwinding Spheres*.⁶⁷ The same

⁶⁷ περὶ τῶν ἀνελιττουσῶν (σφαιρῶν): I am assuming that the work which Proclus mentions here is the same one that Simplicius uses in his commentary. Given that Simplicius' citations from this work plainly concern unwinding spheres, I have taken «ἀνελιττουσῶν» to mean 'unwinding' rather than 'turning'. But one might just as well suppose that the title should be *On the Turning Spheres*. See 135n113.

passage has also been cited by modern scholars⁶⁸ as evidence that Sosigenes observed an annular eclipse, which they then compute to be the annular eclipse of 164 Sep 4, the only such eclipse visible, they claim, in Greece during the relevant period. But this is wishful thinking on both counts. Consider Proclus, *Hyp. ast.* 4.97–99:

Thus, the diameter of the Sun (since [the Sun] is itself extended), [I mean] its apparent diameter, is always ascertained to be the same by means of the dioptra whether the Sun is at apogee or at perigee.⁶⁹ But the apparent diameter of the Moon is greater and smaller at different distances [from Earth]; and only when the Moon is in the [points] of its own circle farthest from the Earth,⁷⁰ when it is plainly full and in conjunction (as it is in solar eclipses), is its apparent diameter the same as the Sun's [apparent] diameter. [130.9]

It is in fact clear to [Ptolemy]⁷¹ that, if this is true, what Sosigenes the Peripatetic has recorded in his [discussions] of the unwinding spheres is *not* true, [namely], that during eclipses near the Earth,⁷² the Sun was observed not to be entirely covered but to extend beyond the disk of the Moon with the extremes of its own circumference and to cast light unimpeded [by the Moon]. Certainly, if one accepts this, either the Sun will exhibit different apparent diameters or the Moon, in respect to the [diameter] that is apparent from the dioptra when [the Moon] is at [points] farthest from the Earth,⁷³ will not be identical to the [apparent] diameter of the Sun. [20]

[Manitius 1909, 130.9–26] [25]

The remark attributed to Sosigenes offers a middle ground between Ptolemy's view that no total solar eclipses are annular and the view found in *P. Par. gr.* 1 col. 19.16–17⁷⁴ (first half of second century BC) and Cleomedes, *Cael.* 2.4.108–115 that all such eclipses are annular. The key point for our purposes is that the remark attributed to Sosigenes stands as a claim about a whole class of observations that are not necessarily his own—note 'during eclipses near the Earth' and the absence of any indication that Sosigenes actually observed one himself. Moreover, if Sosigenes *is* construed to be reporting real observations, we should still hesitate to follow Proclus in supposing that these were observations of annular eclipses rather than

⁶⁸ E.g., Neugebauer 1975, 104n1.

⁶⁹ εἴτε ἀπογείου τοῦ ἡλίου ὄντος εἴτε περιγείου.

⁷⁰ *Hyp. ast.* 4.97 ἐν τοῖς ἀπογείους ... τοῦ ἑαυτῆς κύκλου.

⁷¹ Cf. *Hyp. ast.* 4.95. The reference is to *Alm.* 5.14. Ptolemy does allow that the solar distance varies in his *Hypoth. plan.* [cf. Goldstein 1967, 7; Morelon 1993, 66].

⁷² *scil.* eclipses when both bodies are near the Earth and, hence, when the Moon is apparently *larger* than it is in eclipses far from the Earth.

⁷³ ἐν τοῖς ἀπογείοις.

⁷⁴ = P. Louvre 2388 Ro + 2329 Ro. See Bowen 2008b.

observations of the solar corona during a total eclipse.⁷⁵ There was, after all, no theory in antiquity to explain the light that sometimes appears around the Moon during total solar eclipses and, hence, no way to distinguish such eclipses from annular eclipses. As R. Grant remarks:

Among the various eclipses of the sun recorded as having happened in ancient times, some were, in all probability, annular: but in no instance is the description of the writer sufficiently clear to establish, beyond all doubt, the actual occurrence of an eclipse of this nature. [Grant 1852, 371]

As for my 'in his [discussions] of the turning spheres', the Greek is «ἐν τοῖς περὶ» with the genitive. This locution is found without any substantive specified for «τοῖς» 10 times in the corpus of Proclus' writings. Of these occurrences, two⁷⁶ involve what proves to be a reference by title to treatises or books still extant, Aristotle's *De sensu* and Archimedes' *De sph. et cyl.* And four others, which are found in commentaries on particular treatises, either involve reference to a passage in the treatise being commented on⁷⁷ or to a passage in some other work by the author of the treatise.⁷⁸ The remaining four occurrences (including the one currently under consideration) are, in my view, uncertain: given the locution that Proclus uses, they may involve reference to passages on a certain subject or to treatises by title or by subject. And so any decision about the specific intent of any of these occurrences should be based on independent evidence.

Unfortunately, in the case of Sosigenes and his purported treatise, no such evidence is forthcoming. Accordingly, it is more prudent, I think, to avoid positing a treatise otherwise unattested and to suppose instead that he is referring to discussions. Such caution will seem warranted if one considers the 35 instances in which Proclus actually does supply a substantive to go with «τοῖς», since, for him, the substantive of choice (30 occurrences) is «λόγοις» and it typically signifies a passage (literally, words), discussions, accounts, or arguments. Indeed, there is but one occurrence⁷⁹ which seems to involve the citation of a work by its title—the fact that this locution is balanced by another construction designating Plato's *Phaedrus* suggests this. Otherwise, in the remaining five instances, Proclus uses «γράμ-

⁷⁵ Cf. Philostratus, *Vita Apoll.* 8.23.1–4 and Plutarch, *De facie* 932b–c with Newton 1972, 99–100, 601 and Grant 1852, 367, 371–372, 376–383.

⁷⁶ Kroll 1899–1901, 2.167.10–11; Friedlein 1873, 71.18–19.

⁷⁷ Kroll 1899–1901, 1.41.11–12; Diehl 1903–1906, 3.58.24–25; Manitius 1909, 220.7–15.

⁷⁸ Kroll 1899–1901, 1.170.15–16 with Plato, *Crat.* 392b1–393b6.

⁷⁹ Diehl 1903–1906, 2.105.32–106.2.

μασι» ('writings'), «δόγμασι» ('doctrines'), «παραδεδομένοις» ('views handed down'), «πλάσμασι» ('images' or 'figures'), and «τύποις» ('outlines'). Clearly, only one of these, «γράμμασι»,⁸⁰ would entail reference to a treatise, though not necessarily by title.

COMMENT 12.09

IN DE CAELO 488.21–24 136n119

On 'Saving the Phenomena'

There are numerous ways in which the Greeks expressed the idea of saving the phenomena or appearances. These expressions occur in different contexts and indicate different tasks. In some instances, one is to account for an apparent irregularity and thus to save the phenomena by explaining it away; in others, the task is to explain a regularity and thus to preserve or maintain it; and in others still the meaning of the expression is left vague. With this in mind, let us distinguish the slogan «(δια)σώζειν τὰ φαινόμενα» ('saving the phenomena') from the project itself, and try to determine what the project was originally by considering the early occurrences of the slogan.

Plutarch, De facie 923a

The earliest occurrence of the slogan in this form is found in a fictional dialogue written by Plutarch. Surprisingly enough, though the context is broadly astronomical, Plutarch is not here concerned with the motions of the five planets, but with the thesis that the Earth revolves about the Sun and rotates on an axis:

And Lucius laughed and said: 'Oh sir, just don't bring suit against us for impiety just as Cleanthes thought that the Greeks ought to lay an action for impiety against Aristarchus the Samian on the ground that he was disturbing the hearth of the universe because he sought to save [the] phenomena by assuming that the heaven is at rest while the Earth is revolving along [its oblique circle] and at the same time rotating about its own axis.'

[Plutarch, *De facie* 923a: Cherniss 1957, 55 lightly revised]

The implication of Lucius' remark is that the risings and settings of the Sun and fixed stars seen each day on the eastern and western horizon respectively, and the fact that the Sun's rising point on the eastern horizon

⁸⁰ Kroll 1899–1901, 2.113.8–9.

moves north and south along the horizon during the year, and so forth, can be saved (that is, explained) on two hypotheses. The first is geocentric: it locates an immobile Earth at the center of the celestial sphere and has the Sun as well as this sphere revolving around it, the Sun moving on a circle that is oblique to the revolution of the celestial sphere. The second is heliocentric: it places the Sun at the center of a stationary celestial sphere and has the Earth rotating on its axis as it revolves about the Sun on a circle that is oblique to the axis of rotation. The choice between these hypotheses is momentarily cast as a matter of piety.

Archimedes, Arenarius 1.4–7

Should we say, then, that Aristarchus characterized his project as one of saving the phenomena? There is certainly no surviving treatise by Aristarchus to confirm the attribution made in the *De facie*. Whether there ever was one is, in fact, a nice question concerning how one interprets the earliest text ascribing to Aristarchus this thesis about the Earth's motion. This text is the preface to Archimedes' *Arenarius*, a treatise that broaches astronomical matters because it aims to demonstrate that Archimedes' system for expressing numbers is capable of representing numbers larger than the number of grains of sand that it would take to fill the cosmos or celestial sphere.

In this preface, Archimedes (died –211), a near contemporary of Aristarchus, writes:

You [*scil.* King Gelon] understand that the sphere of which the center of the Earth is the center and the radius equal to the line between the center of the Sun and the center of the Earth is called cosmos by the majority of astronomers, since you have learned these things in the demonstrations written by astronomers. But Aristarchus of Samos has made available illustrations of certain hypotheses and from what is laid down in these it follows that the cosmos is many times greater than the one just mentioned. For, he posits that the fixed stars and the Sun remain at rest; that the Earth revolves on the circumference of a circle about the Sun, which is situated in the center of its course; and that the sphere of the fixed stars, which is situated about the same center as the Sun, is so great in size that the circle on which it is posited that the Earth revolves has the same sort of relation to the distance of the fixed stars as the center of the sphere has to its surface. But it is indeed readily apparent that this is impossible. For, since the center of a sphere has no magnitude, one should not posit that it has any ratio to the surface of the sphere at all. One should, however, understand that Aristarchus has this in mind: whereas we posit that the Earth is, as it were, the center of the cosmos, the sphere on which lies the circle along which he posits that the Earth revolves has to the sphere of the fixed stars the ratio that the Earth has to what we call

the cosmos. For, he adapts his demonstrations⁸¹ of the phenomena to what is laid down in this way; and he especially appears to posit that the magnitude of the sphere in which he makes the Earth move is equal to what we call the cosmos.
[Archimedes, *Arenarius* 1.4–7]

The question of a treatise comes to a point in the phrase «ὑποθέσιων τινῶν ἐξέδωκεν γραφάς» which I have translated by ‘made available illustrations of certain hypotheses’. Heath proposes that it means ‘brought out a book of certain hypotheses’.⁸² Both renderings are acceptable as far as the Greek goes, so it is unfortunate that there is no credible way to decide the question given the evidence at hand.

According to Archimedes, Aristarchus posited that:

- the fixed stars and the Sun remain in place,
- the Earth travels around a circle with the Sun at its center, and
- the sphere of the fixed stars is so great that the circle on which the Earth travels stands in relation to the radius of the celestial sphere as the center of a sphere to its surface.

The first two theses are obviously consistent with Plutarch’s *De facie* 923a. For present purposes, however, it is important to notice that Archimedes says nothing about Aristarchus’ reasons for positing terrestrial motion. Instead, his attention is captured by the claim that a point and a sphere’s surface can be in a ratio. Since he regards this claim as mistaken—these relations cannot, for instance, exceed one another when multiplied [cf. Euclid, *Elem.* 5 defs 3–4]—he recasts Aristarchus’ analogy. As he sees it, what Aristarchus really meant was that the ratio of the Earth to the sphere containing the circle of the Earth’s motion is the same as the ratio of this sphere to the celestial sphere. Though Archimedes’ revision is motivated by technical concerns about what a ratio is as well as perhaps by the nature of the project that he undertakes in the *Arenarius*, Archimedes does support it by adding that Aristarchus ‘adapts his demonstrations of the phenomena to what is laid down in this way’. But what these phenomena are and exactly how Aristarchus demonstrated them is left utterly unexplained. Equally noteworthy is that Archimedes does not describe whatever Aristarchus supposedly did as an exercise in saving the phenomena.

Consequently, in the absence of further information from Archimedes, we should not take it for granted that a demonstration (ἀπόδειξις) here is

⁸¹ ἀποδείξεις.

⁸² Heath 1913, 302–303.

a mathematical deduction, or an argument that defends a thesis by adducing supporting considerations, or even an exhibition of how a scheme or configuration might work, to name but three possibilities. Moreover, we should not suppose without argument that a hypothesis (ὑπόθεσις) here is, for instance, a claim put forward for discussion rather than a point of agreement or a presupposition or premiss of deductive argument. In short, we should not prejudge which of the various possible meanings of 'demonstration' and 'hypothesis' that Archimedes intends.

Thus far, then, we have Archimedes as the earliest source of the view that Aristarchus thought the Earth rotates on an axis and revolves about the Sun which is at the center of a fixed celestial sphere. But Archimedes' testimony leaves unstated why Aristarchus proposed this: all Archimedes indicates is that he thinks it had something to do with some phenomena. And apart from this, Archimedes' testimony not only makes one wonder what the majority of astronomers whom he mentions thought about the five planets and whether they bothered to treat them as distinct objects of study—the remark that they identify the cosmos with the sphere containing the circle on which the Sun travels does seem peculiar—it also introduces another problem. For, the *De magnitudinibus et distantiis solis et lunae*, a treatise usually ascribed to Aristarchus, assumes that the Sun and Moon revolve in homocentric circles about the Earth. I will return to this, after considering three more passages that have been brought to bear on the question of what Aristarchus was proposing.

Seneca, *Nat. quaest.* 7.2.3

The first comes from Seneca (–4 to 65), who writes that

it will also be relevant to discuss these things so that we may know whether the universe rotates as the Earth stands still or whether the Earth rotates as the universe stands still. For, there have been those who affirmed that we are the ones whom the nature of things causes to move, though we are not aware of it; and that the risings and settings do not occur by virtue of the motion of the heavens but that we ourselves rise and set. The subject is worthy of thought so that we may know in what condition we live, whether we have drawn as our lot a dwelling-place that is the most inert or the fastest moving, whether god makes all things move around us or makes us move around (them).

[Seneca, *Nat. quaest.* 7.2.3]

Here we find that those who adopted the thesis that Earth rotates on its axis supposedly wished to account for horizon phenomena, particularly, the diurnal risings and settings of the fixed stars. It is worth noting, however, that Seneca makes no mention of the Earth's motion about the Sun, a

motion that would surely help in accounting for these risings and settings throughout the year.⁸³ Thus, one may well doubt that Seneca is in fact alluding *specifically* to Aristarchus, as some have thought.

In fact, Seneca may only have in mind the dispute between Aristotle and those who agree with him in putting the Earth at the center of the cosmos but who object to Aristotle's argument [cf. *De caelo* 2.13–14, esp. 297a2–6] that the motions of the constellations seen in the night sky follow from our being on a motionless Earth at the center of a rotating celestial sphere. Indeed, Aristotle himself [*De caelo* 293b30–32] finds in Plato's *Timaeus* [cf. 40b8–c3] the thesis that the Earth is at the center of the cosmos but possessed of an axial rotation. Now, whether Aristotle is right about Plato's meaning in this passage is beside the point: for our purposes, it suffices that the thesis is directly attested in a datable, extant text written prior to Seneca in a context that differs from the one indicated in Archimedes' report about Aristarchus.

Still, even if Seneca means an allusion to Aristarchus, we must note that, while he does indicate the phenomena to be accounted for, he does not characterize the argument or demonstration involved.

Stobaeus, Ecl. 1.25.3k

As for the Earth's motion about the Sun, this is next mentioned by Stobaeus, a writer in the fifth century AD:

Aristarchus determines that the Sun is among the fixed [celestial bodies], and that the Earth moves around the solar circle and is cast into shadow according to its inclinations
[Stobaeus, *Ecl.* 1.25.3k]

But here again there is no statement of why Aristarchus made these claims, though Heath surmises from the reference to the Earth's inclinations that he was concerned to explain climatic differences among the seasons.⁸⁴ Further, as before, there is no general characterization of what Aristarchus was doing.

Plutarch, Plat. quaest. 1006b–c

In sum, Plutarch's *De facie* 923a is the earliest extant text to assert that Aristarchus (or anyone else for that matter) sought to 'save the phenomena'. Yet, like Archimedes before him, Plutarch does not specify what these

⁸³ Cf. Sextus Empiricus, *Adv. math.* 10.174.

⁸⁴ Heath 1913, 305.

phenomena are or what saving them entails beyond explaining them as regular occurrences. This situation is hardly improved or clarified when Plutarch writes:

What does Timaeus mean by saying that souls were strewn as seed into Earth and Moon and all the other instruments of time?

Was he giving the Earth motion like that of Sun and Moon and the five planets, which, because of their turnings,⁸⁵ he called instruments of time; and ought the Earth coiling about the axis extended through all be understood to have been devised not as confined and at rest but as turning and whirling about, as Aristarchus and Seleucus have later shown, the former hypothesizing (ὑποτιθέμενος) it only but Seleucus stating it as a fact as well?

[Plutarch, *Plat. quaest.* 1006b–c: cf. Cherniss 1976, 76–79]

Heath⁸⁶ cites Simplicius, *In phys.* 2.2 and conjectures that Plutarch is ascribing to Aristarchus a distinction between stating a hypothesis and affirming it as a fact that derives from a distinction between kinds of discourse about the heavens—namely, that of the scientist who aims only to put forth hypotheses capable of accounting for the phenomena, and that of the physical theorist who is obliged to determine what is really the case. But, in light of the interpretation of the relevant passage from *In phys.* 2.2 given in Chapter 2 [37–57], I would say that this conjecture misses the mark.

Though Simplicius *does* state that astronomers are tasked with saving the phenomena, he also indicates that the hypotheses which they devise to do this are in fact held to be the case, that is, true, though without argument beyond the fact that the hypotheses save the phenomena. Thus, from Simplicius' standpoint, Heath's treating Aristarchus as an astronomer puts Aristarchus' use of geocentric hypotheses in his *De magnitudinibus* at odds Archimedes' ascription to him as an astronomer of heliocentrism. One might, of course, contend that Archimedes is just wrong or suppose that Aristarchus changed his mind after or before writing his treatise. But I suspect that the problem actually lies with Plutarch.

In his *Plat. quaest.*, Plutarch has Aristarchus put forward his heliocentric hypotheses not as a fact but as a subject or starting point for discussion—a perfectly common usage of «ὑπόθεσις»—which Seleucus (second century BC) then adopted as an *astronomical* hypothesis by offering it as the reality that saved the phenomena. Thus, Plutarch effectively casts Aristarchus as a philosopher; it is Seleucus who is the astronomer.

⁸⁵ διὰ τὰς τροπὰς: see p. 240.

⁸⁶ 1913, 305–306.

In his *De facie*, however, Plutarch has Aristarchus putting heliocentrism forward as an astronomical hypothesis said to save the phenomena, in a way that Cleanthes, a Stoic philosopher, took to constitute an impious claim about what is in fact the case. Just how Plutarch actually saw Aristarchus' contribution or imagined its ontological commitment is unclear. One may well wonder, given that the *De facie* is a dialogue with dramatic elements, whether Lucius' talk of Aristarchus' saving the phenomena by means of a heliocentric hypothesis that Cleanthes understood as a claim about reality is but a dramatic fiction to make the charge of impiety appropriate. After all, offering such a hypothesis as a mere starting point for discussion would be weak beer when compared to proposing that it constitutes the *realia*, and probably would not have been perceived as credible grounds for incurring the philosopher's accusation. In any event, the immediate context in which the passage occurs is not a dialectical exercise but a philosophical discussion of the physical constitution of the Moon. And so here again, there is a dramatic reason for construing Aristarchus' heliocentrism as a thesis about how things really are.

Thus, given the possibility that *De facie* 923a takes dramatic license in ascribing anachronistically to Aristarchus a project described as one of saving the phenomena, and given also that there is otherwise no earlier source that construes whatever Aristarchus did as a project in saving the phenomena, and in light of the fact that this is the earliest occurrence of the slogan «τὰ φαινόμενα σώζειν», we really should try to find its original context elsewhere in order to ascertain its earliest meaning in the history of the interpretation of astronomy.

Now, as I have already indicated, my *working* hypothesis is that this slogan was actually crafted in the first century BC with a view to the efforts at the time to account for the motions of the five planets by explaining away their apparent irregularity or unsmoothness. In other words, I think that there is good reason to suppose that Simplicius' report of Alexander of Aphrodisias' careful (φιλοπόνως)⁸⁷ citation of Geminus' summary outline of a passage from the *Meteorologica* by Posidonius is reliable in that its key language and ideas are not accretions due to Alexander or Simplicius but actually derive from Posidonius/Geminus.

Demonstrating or, more likely, supporting, this hypothesis will take us far beyond the present remit. So, to conclude this comment, I will limit

⁸⁷ On this adverb, see 11n38.

attention to a passage from Geminus' *Introductio astronomiae* which, I think, was written in the context of Posidonius' remarks about astronomy and physical theory.⁸⁸

Geminus, Intro. ast. 1.19–22

Granted, Geminus does not here use the language of saving phenomena. Nevertheless, he is the first to identify this explicitly as a distinct *task* in astronomy:

It is posited⁸⁹ for astronomy⁹⁰ as a whole that the Sun, Moon, and five planets move at a constant speed in a circle,⁹¹ and in a direction opposite to [the daily rotation of] the cosmos. For, the Pythagoreans, who were the first to come to investigations of this sort, hypothesized⁹² that the motions of the Sun, Moon, and five planets are circular and smooth. The reason is that they did not admit in things that are divine and eternal such disorder that sometimes [these things] move more quickly, sometimes more slowly, and that sometimes they stand still—which they in fact call stations in the case of the five planets. For, not even in the case of a man who is well behaved and orderly would one accept such unsmoothness of motion in his modes of progression.⁹³ For, the necessities of life are often causes of slowness and speed for men; but, in the case of the imperishable nature of the celestial bodies, no cause of speed and slowness can be introduced. For which reason they have proposed the following question: How can the phenomena be explained by means of circular, smooth motions?

Accordingly, we will give the explanation concerning the other celestial bodies elsewhere;⁹⁴ but right now we will show concerning the Sun the reason why, though it moves at a constant speed, it traverses equal arcs in unequal times.⁹⁵ [*Intro. ast. 1.19–22*]

The only difficulty that this passage poses for the suggestion that *De facie* 923a retrojects a slogan and activity to Aristarchus in the third century that

⁸⁸ Cf. Bowen 2007, 330–334, 344–348; Bowen 2012e.

⁸⁹ ὑπόκειται: the present tense of «ὑπόκειμαι» is often used instead of the perfect passive tense of «ὑποτίθημι» and thus often means (as it does here) 'it is assumed as a hypothesis' or 'it is hypothesized.' Cf. «ὑπέθεντο» below.

⁹⁰ ἀστρολογία.

⁹¹ ἰσοταχῶς *scil.* they each travel equal arcs of their circular paths in equal times [cf. 1.31].

⁹² ὑπέθεντο.

⁹³ πορεῖα: cf. Aristotle, *Eth. Nic.* 1125a12–16. Even less, then, would one ascribe such disorderly motion to the divine celestial bodies.

⁹⁴ Geminus does not return to this in the *Intro. ast.* Perhaps this was a topic to be taken up in a treatise for more advanced students.

⁹⁵ For the Greek text, I have consulted both Manitius 1898 and Aujac et al. 1975.

actually derives from the first in a somewhat different context, comes with Geminus' mention of the Pythagoreans. But we should not suppose immediately that when Geminus assigns this project of explaining (or in other terminology, saving) the planetary phenomena to 'the Pythagoreans,' he means the *early* Pythagoreans.⁹⁶ There is, after all, no good evidence dating from the fifth and fourth centuries warranting the claim that the early Pythagoreans (or any early Greek for that matter) were aware of such characteristic planetary motions as their stations and retrogradations.⁹⁷ In fact, it would be more in line with what we actually do know to suppose that, while Geminus might mean the early Pythagoreans, he could just as well mean the Pythagoreans of the revived Pythagorean movement that was contemporary with him and Cicero, since this movement did involve interest in horoscopic astrology and study of the planetary motions.⁹⁸ Moreover, if Geminus does mean the *early* Pythagoreans, he could be relying on literature ascribed to them but written in the late second and first centuries BC when the planetary motions became known in the Greco-Roman world.⁹⁹

Conclusion

Given the present state of the evidence, the most that we should allow is that the project of explaining the retrogradations and stations of the five planets only began to take shape after the late second century BC as Greco-Latin writers tried to address the problem of planetary motion in greater detail than ever before. The slogan, 'save the phenomena,' first appears in a text written some years after this, however. There is, of course, no way to determine whether this slogan was coined specially to encapsulate this new project in astronomy or whether it was borrowed from an analogous project in a different domain. Nevertheless, I submit that, so far as Greco-Latin astronomy is concerned, its original scope was precisely this task of explaining planetary stations and retrogradations away, though, apparently, it soon was generalized to cover explanations that accounted for other astronomical phenomena.

⁹⁶ As does van der Waerden [1988, 107–108], for example: cf. Evans and Berggren 2006, 49–50.

⁹⁷ See Comment 12.07, pp. 230–248.

⁹⁸ See Bowen 2012d.

⁹⁹ See Comment 12.39, pp. 297–298.

137n121 COMMENT 12.10

IN DE CAELO 488.27–30

An Alternative Reading

I have translated the question following Moerbeke's text,

*quae necessitas tamquam secundum veritatem pluribus existentibus corporibus circa unumquodque erraticorum et propter hoc pluribus motibus sic causam querere, propter quid propinqui non erratice planete pluribus feruntur lationibus quam extremi?*¹⁰⁰ [Bossier n.d.b, 515.5–10]

What need is there to seek in this way the reason why the planets proximate to the fixed [sphere] perform more motions than the ones that are last, as though for each of the wandering stars there are in truth a greater number of bodies [than one] and because of this a greater number of motions?¹⁰¹

which has 'erraticorum' instead of «τῶν ἀπλανῶν» ('than the fixed spheres') found in 488.29 of Heiberg's text:

τίς ἀνάγκη ὡς κατὰ ἀλήθειαν πλείονων ὄντων σώματων περὶ ἑκάστον τῶν ἀπλανῶν καὶ διὰ τοῦτο πλείονων κινήσεων οὕτως αἰτίαν ζητεῖν, διὰ τί οἱ προσεχεῖς τῇ ἀπλανεῖ πλάνητες πλείονας φέρονται φορές τῶν ἐσχάτων; [488.27–30]

What need is there to seek in this way the reason why the planets proximate to the fixed [sphere] perform more motions than the ones that are last, as though in each case there are in truth a greater number of bodies than the fixed [spheres] and because of this a greater number of motions?¹⁰²

In short, given that there is reason to doubt that Aristotle's homocentric theory, for example, represents the way things really are, Simplicius wonders about the sense of proceeding as though there were more than one body associated with each planet and, hence, more than one (proper) motion, and then worrying about the first ἀπορία. He presumably does not mean by this to deny that the planets *appear* to make more than one motion: his concern is, I take it, that addressing the first ἀπορία without knowing how many motions each planet *really* does make is pointless.

If we retain «τῶν ἀπλανῶν», the thought borders on nonsense. Still, given that each of Aristotle's planetary systems has a single sphere that reproduces

¹⁰⁰ 515.10 reading 'extremis'.

¹⁰¹ Cf. Mueller 2005, 29 and n95. Mueller's translation goes astray, however, by rendering the occurrences of «πλείονων», a comparative adjective, by 'several'.

¹⁰² Cf. Grosseteste's

quae necessitas ut secundum veritatem pluribus existentibus corporibus circa unumquodque non errantium et propter hoc pluribus motibus, sic causam quaerere, propter quid proximi aplani planetae plures feruntur lationes extremis? [Bossier n.d.a, 168.1–5]

the motion of the fixed or celestial sphere, Simplicius would have to be thinking of the system of homocentric winding and unwinding spheres for each planet and asking very awkwardly why we should suppose that there is more than one (proper) motion.

COMMENT 12.11

DE CAELO 292B29–30

139n137

The Living Sources of Celestial Motion

In *De caelo* 292b29, I take «τῆς ζωῆς καὶ τῆς ἀρχῆς» ('of the living source') as a hendiadys.¹⁰³

De caelo 292b28–30 is difficult. At issue is the antecedent of «ἐκάστης» in

νοῆσαι γὰρ δεῖ τῆς ζωῆς καὶ τῆς ἀρχῆς ἐκάστης πολλὴν ὑπεροχὴν εἶναι τῆς πρώτης πρὸς τὰς ἄλλας.

Regrettably, neither Grosseteste's translation

*intelligere enim oportet vitae et principii uniuscuiusque multam superexcellen-
tiam esse primae ad alias* [Bossier n.d.a, 169.21–23]

nor Moerbeke's lemma

De dubitatione autem usque illuc multam excellentiam esse primae ad alias [Bossier n.d.b, 520a]

are any help in this: both translators render «κίνησις» ('motion'), one possible referent of «ἐκάστης», by 'latio', 'translatio' as well as by 'motus'. Moreover, though these lines from the *De caelo* would be easier if one followed some mss and Simplicius [490.7–8] in omitting «ἐκάστης», there is little real doubt that it belongs in the text.¹⁰⁴

So, in *De caelo* 292b29–30, what exactly is first and greatly superior in «τῆς ζωῆς καὶ τῆς ἀρχῆς ἐκάστης ... τῆς πρώτης»? As it turns out, translators differ on whether it is a motion¹⁰⁵ or what is described in the phrase «τῆς ζωῆς καὶ τῆς ἀρχῆς ἐκάστης».¹⁰⁶

¹⁰³ So Guthrie 1960, 213 'each of these living principles'. But see Leggatt 1995, 149 'the life and the principle of each locomotion'; Pellegrin 2004, 261 'pour la vie comme pour chaque principe' [but see 439n13 'concernant la vie et le principe']; Mueller 2005, 30 'with regard to each's life and sovereignty'.

¹⁰⁴ Cf. Moraux 1965, 84, Bossier n.d.a, 169.21–23.

¹⁰⁵ See, e.g., Leggatt 1995, 149; Pellegrin 2004, 261 and n13.

¹⁰⁶ See Moraux 1965, 83–84; Mueller 2005, 30.

In my translation, I construe «τῆς ζωῆς καὶ τῆς ἀρχῆς ἐκάστης» as a genitive of connection ('regarding ...')¹⁰⁷ and take Aristotle to mean that there is a great superiority of the first living source of motion, thus abandoning my effort of 2008d, 48. In other words, I take Aristotle's point to be that each of the celestial (proper) motions derives from a living source and that the first or outermost living source is greatly superior to the rest because it causes the other living sources of motion to perform the diurnal rotation [cf. *De caelo* 291b31–32]. This seems preferable to supposing that what is first is the first motion, since this makes «τῆς ζωῆς καὶ τῆς ἀρχῆς ἐκάστης» odd if not irrelevant.

But what are these living sources of motion? They are certainly not souls themselves [cf. *De an.* 413a20–b4] but ensouled celestial bodies (viz. celestial animals). Plainly, the first such ensouled body is the celestial sphere. As for the planetary motions, 293a4–11 make clear, I think, that each of the homocentric spheres required to produce the motion of a given planet is ensouled.

If this is right, the upshot is that *De caelo* 2.12 diverges both from Plato, *Tim.* 41d4–e1 by denying that the planets themselves are ensouled and the sources of their own motions, and from the account found in *Meta.* Λ.8 by proposing ensouled spheres rather than unmoved movers as sources of motion in the heavens.

146n173 COMMENT 12.12

IN DE CAELO 493.15–17

The Third Solar Motion

This claim about the Sun's motion is also found in the commentary on *Meta. E–N*.¹⁰⁸ It first appears in Hipparchus, *In Arat.* 1.9.1, where it is ascribed to Attalus, who reportedly argued that one should follow the manuscript variant for Aratus, *Phaen.* 467 asserting that the tropic and equinoctial circles have breadth rather than the one stating that they are without breadth. As Hipparchus [*In Arat.* 1.9.2] writes:

[88.15] The reason is that the astronomers¹⁰⁹ too, [Attalus] says, hypothesize that the tropic, equinoctial, and zodiacal circles possess breadth because the Sun does not always make its solstices on the same circle, but sometimes farther north and sometimes farther south. [Manitius 1894, 88.13–18]

¹⁰⁷ Smyth 1971, §1381.

¹⁰⁸ See Hayduck 1891, 703.23–28.

¹⁰⁹ ἀστρολόγοι.

and then adds:

And Eudoxus too claims that this occurs. At any rate (γούν), he says the following in his *Enoptron*: 'Even the Sun is observed making a deviation in the positions of its solstices, a deviation that is rather unclear to many and utterly insignificant.' [88.20] [Manitius 1894, 88.18–22]

What has passed unnoticed about these lines is that Hipparchus is inferring that Eudoxus would agree with Attalus about the Sun's motion on the basis of a few lines from Eudoxus' *Enoptron*, and that he is not in fact certain that these lines do indeed support this inference.¹¹⁰ In other words, Hipparchus leaves open the question whether Eudoxus actually thought that the observed variation in the position of the solstices on the horizon entailed that the solstitial and equinoctial circles have breadth. Hipparchus then goes on in *In Arat.* 1.9.3–13 to refute Attalus by arguing that the center of the Sun does not stray from the zodiacal circle, and that neither Aratus nor the astronomers (μαθηματικοί) suppose the tropic, zodiacal, and equinoctial circles to have breadth.

This refutation also challenges the assumption that Eudoxus (always?) held that the Sun had three motions. If I understand Mendell,¹¹¹ the citation of Eudoxus at *In Arat.* 1.9.2 should mean that, while the second and third spheres combine to produce an annual solar motion which is not quite circular, the deviations are very small and virtually unobservable.

But, this is not how Hipparchus attacks Attalus' thesis: he does not proceed by pointing out that there are no observable deviations in the Sun's course from a great circle. Instead, to make the case that the fundamental circles defined on the celestial sphere are without breadth (and so exactly circular), Hipparchus adduces:

- the fact that eclipses occur when the bodies involved are on the zodiacal circle,
- the practice of the μαθηματικοί,
- the fact that the equinoxes and solstices each take place during the course of a single day, and
- Aratus' own words.

His conclusion is, effectively, that no 'proper' astronomer (μαθηματικός),¹¹² as opposed to an ἀστρολόγος, holds that the solstitial and equinoctial circles do

¹¹⁰ This, I take it, is the force of the particle γούν: cf. Smyth 1971, § 2820.

¹¹¹ Mendell 1998, 188–189; 2000, 95–100.

¹¹² Cf. *In Arat.* 1.1.8, 1.9.9.

have breadth and, therefore, that the Sun's path was not *exactly* the zodiacal circle. That he mentions in this context Aratus, who, he elsewhere says, followed the μαθηματικοί, a group which included Eudoxus,¹¹³ in versifying the latter's *Phaenomena*, is significant.¹¹⁴

148n183 COMMENT 12.13

IN DE CAELO 494.9–12

An Error in the Solar Hypothesis?

The claim that the westward motion of the second sphere is faster than that of the third and smallest sphere—which means that the period of the third sphere's rotation is longer than that of the second sphere—is not in Aristotle's account. As Heath sees it, if the period of the motion of the second sphere is a year, and if the third sphere is the one with the much slower motion, the Sun will spend more than half a year above the zodiacal circle and then more than half a year below.¹¹⁵ Thus, Heath (and others) propose to correct Simplicius by supposing that, for Eudoxus, the Sun's slow motion belongs to the second sphere and its annual motion to the third. Mendell [1998, 2000] has recently disputed the validity of this criticism and has offered an alternative reconstruction.¹¹⁶

148n184 COMMENT 12.14

IN DE CAELO 494.20–22

The Length of the Day

While Simplicius is right so far as he goes, his allusion to the fact that the day is longer than one complete revolution of the celestial sphere is, under the circumstances, unsophisticated. The problem is that he treats the day as the interval from one setting of the Sun to the next, that is, from one horizon crossing to the next solar crossing of the same horizon. Such an account does not isolate the contribution made by the observer's latitude to the length of the day. It is for this reason that Ptolemy [*Alm.* 3.9] defined the day as the interval from one solar crossing of the meridian (*scil.* the great circle through the celestial poles and the observer's zenith point) to the next solar

¹¹³ See *In Arat.* 2.2.19; cf. 2.1.19–22.

¹¹⁴ On Hipparchus' treatment of Aratus, see Mastorakou 2007.

¹¹⁵ Heath 1913, 198.

¹¹⁶ See Comment 12.17, pp. 266–268.

crossing of the same limb of the meridian. Ptolemy's definition of the day permits quantification of the equation of time, that is, the amount by which the length of any given day differs from one full revolution of the celestial sphere. In effect then, Simplicius takes recourse to a crude understanding of the day that is found in Geminus, *Intro. ast.* 6.1–4 and Cleomedes, *Cael.* 1.4.72–89, for example.

COMMENT 12.15

IN DE CAELO 495.5–8

149n186

On Latitude (πλάτος)

Simplicius' exposition here is less than careful. Up to this point and afterwards [see especially 497.4–5], «πλάτος» in phrases such as «κατὰ πλάτος» and «εἰς πλάτος» is, to use the technical term, 'latitude', where latitude is a vertical distance above (or below) a reference circle, specifically, the zodiacal circle. (If the reference circle were the celestial equator, πλάτος would be declination.) In effect, Simplicius is following usage that had been in place from at least the first century BC and is clear in the works of Proclus.¹¹⁷ Thus, in 495.4–5, the distance between the poles of the two spheres is said to be equal to the Moon's greatest displacement in latitude, that is, in its motion above (or below) the zodiacal circle. Yet, in 495.5–8, Simplicius calls the *sum* of these maximum displacements above and below the zodiacal circle a πλάτος and affirms that the distance between the poles of the second and third lunar spheres is one half of it. Plainly, he is using «πλάτος» in another sense to designate the distance between two latitudes (hence, my 'breadth [of latitude]'). Though such usage in talking of the planetary motions is with precedent,¹¹⁸ it is awkward in this context.

COMMENT 12.16

IN DE CAELO 495.10–13

149n188

The Third Lunar Motion

In writing of the westward motion in longitude of the points of the Moon's greatest latitude, Simplicius is *effectively* describing the motion of the lunar nodes (points where its orbit passes through the ecliptic). Understanding

¹¹⁷ See e.g., *Hyp. ast.* 3.26–28, 4.12. Cf. Hiller 1878, 134.13–135.6; Cleomedes, *Cael.* 2.4.1–5.

¹¹⁸ See, e.g., Aujac 1975, 291 s.v. «πλάτος» on Geminus' usage; Hiller 1878, 135.12–21; Cleomedes, *Cael.* 1.2.49 and 74, 2.6.9 and 96.

this westward motion of the lunar nodes is essential to the theory of eclipses. That Simplicius talks of the longitudinal motion of the points of the Moon's greatest displacement in latitude rather than of the motion of the lunar nodes may indicate that he has been influenced by Ptolemy's practice [*Alm.* 5.8–9] of computing a planet's argument of latitude starting from its northern limit (the place on the zodiacal circle that is reached when the Moon is at its farthest latitude north of this circle), a practice that has several advantages over taking one of the nodes as a starting point in computing the occurrences of eclipses [cf. *Alm.* 6.5]. In any case, in introducing his own descriptive account of eclipses, Theon of Smyrna writes of the regression of the lunar nodes,¹¹⁹ except that he has the nodes going in the wrong direction (εἰς τὰ ἐπόμενα τῶν ζῳδίων); whereas Cleomedes [*Cael.* 2.5.141–147] does not mention any motion of the lunar nodes at all.¹²⁰

For some scholars, the question has been whether one should rely on this passage and ascribe to Eudoxus knowledge of the regression of the lunar nodes. Victor Thoren [1971] rightly treats the question as one about eclipses, but specifies it as one about whether Eudoxus knew that they can occur at any point of the zodiacal circle and then argues (in support of Ideler and Schiaparelli) that we should. Dicks, however, maintains quite sensibly that we should not.¹²¹

149n190 COMMENT 12.17

IN DE CAELO 495.13–16

An Error in the Lunar Hypothesis?

According to Heath, Simplicius is again in error about the second and third spheres: if the period of this slow westward motion of the nodes is 223 synodic months, say, it follows in Simplicius' account that the Moon will pass through each node once in this period and, thus, that it will spend half of this period (roughly 9 years) above the zodiacal circle and then half below.¹²² Heath's 'solution' is to suppose that, for Eudoxus, the third sphere is for the Moon's return to a given node (the draconitic month) along a circle that is inclined to the zodiacal circle at an angle equal to the Moon's greatest

¹¹⁹ Hiller 1878, 194.13–195.4.

¹²⁰ Cf. Bowen and Todd 2004, 152n32.

¹²¹ Dicks 1970, 178–181. See also Bowen 2001, 2002. On Mendell's interpretation of these lines, see Comment 12.17 below.

¹²² Heath 1913, 197, which follows Ideler.

latitude, and that the second sphere is for the slow motion of the nodes along the zodiacal circle from east to west.¹²³

Recently, Mendell¹²⁴ has proposed that modern critics have erred in assuming that the motion of the second lunar sphere is for the Moon's *mean* sidereal or zodiacal motion. As he sees it, Simplicius does not in fact go astray at all in his description of the second and third lunar spheres: for Mendell, Simplicius' error, such as it is, lies in not explaining that the eastward motion of the second lunar sphere accounts for the Moon's eastward motion but not its period, and that the period of the third sphere's eastward motion is distinct from the effect of this third sphere in causing the eastward motion of the points of the Moon's greatest latitude. Mendell's remark is well taken: Simplicius does not identify the periods of the motions of the second and third spheres of either the Sun or the Moon.¹²⁵ But there is a critical problem with the dependence of Mendell's reconstruction on his finding that 'the hippopede is implicit in any model of celestial motion involving two or more spheres rotating at some angle to each other' [1998, 188], and with his taking for granted that this was known to Simplicius (to say nothing of Eudoxus). It is surely significant that Simplicius himself mentions the hippopede *only* in reference to the third and fourth planetary spheres [496.23–497.5], a very special case in which the two inclined spheres rotate in opposite directions at the same speed. In short, Mendell's reconstruction is liable to the charge of committing the fallacy of implication, that is, the fallacy of attributing to Simplicius a mathematical consequence of what he writes.¹²⁶

Incidentally, I would not concede that, if it is possible to read Simplicius' words in a way which avoids an error that he seems to make or not to comprehend, this better reading of what he says derives from another source [so Mendell 2000, 60]. This 'principle', which Mendell labels 'lectio indocti doctior potior', is hardly compelling as a general rule: moreover, in this instance at least, it is, I think, no more than a pretext for reading a reconstruction into the past. To put it baldly, *even if* Simplicius makes an avoidable mistake in

¹²³ Cf. Comment 12.11, pp. 261–262. For objections to such interference with the transmitted text, see Dicks 1970, 181; Bowen 2001 and 2002.

¹²⁴ See Mendell 1998, 191–194; 2000, 100–104.

¹²⁵ Simplicius' remark at 494.26–28 that the second sphere of the Moon moves in the same way as the second sphere of the Sun seems limited to the fact that each is for motion along the zodiacal circle.

¹²⁶ Cf. Robinson 1966, 3–4. For criticism in other terms of the reconstructions offered by Heath and Mendell, see Yavetz 2003.

his account of the second and third solar/lunar spheres, this would hardly license the claim that someone earlier got it right.

Now, Mendell [2000, 95] *does* believe that 493.11–498.1¹²⁷ derives from Eudemus (or a ‘synthesis of Theophrastus and Eudemus’), though he offers no good argument in support of this beyond the tendentious claim that his interpretation of this passage is consistent with this assumption. Note, however, that this passage does not fit with the explicit citations of Eudemus’ *History of Astronomy* that we find elsewhere: these other citations indicate a digest organized by person listing their contributions to astronomy without explanation or criticism.¹²⁸ Furthermore, so far as his explanation of *Meta.* A.8 is concerned, Simplicius explicitly turns to an authority (Sosigenes) for guidance only with regard to the question of the unwinding spheres: in 493.11–498.1, he is *ostensibly* speaking *propria voce*.¹²⁹

150n193 COMMENT 12.18

IN DE CAELO 495.23–29

Values for the Sidereal Periods

These are values for the zodiacal or sidereal periods of the five planetary bodies. Except in the case of Mars, the values which Simplicius reports are the same as those found in Geminus, *Intro. ast.* 1.24–30 and Cleomedes, *Cael.* 1.2.22–36.¹³⁰

¹²⁷ Actually, Mendell says that the text at issue runs from 493 to 499 in Heiberg’s edition. But this overlooks the fact that Simplicius explicitly introduces Sosigenes at 498.2 and cites him extensively in what follows.

¹²⁸ Cf. 488.18–24; Bowen 2003a, 315–318.

¹²⁹ I will pass over the vexed questions of the relation of Simplicius’ remarks on *Meta.* A.8 in his *In de caelo* 2.12 and the commentary on Aristotle’s *Meta.* edited by Hayduck [see 1891, 702.36–706.15], and of whose commentary *In de caelo* it is that the author of the latter refers to in 703.14–16.

For present purposes, it is important to distinguish those passages in which Simplicius explicitly mentions or quotes the views of others from those in which he may be drawing tacitly on previous work. The burden of proof lies heavily on those who suppose that a given passage is an instance of the latter, especially when the work putatively used in this way is no longer extant. Still, should one imagine that anyone has made such a case regarding 493.11–498.1 and its dependence on the commentary on Aristotle’s *Meta.*, this merely pushes back my criticism of Mendell’s ‘principle’ and reconstruction, since the *In meta.* seems to treat the lunar motions as Simplicius does.

¹³⁰ Both Cicero [*De nat. deor.* 2.53] and Theon of Smyrna [Hiller 1878, 136.8] assign Mars a sidereal period of less than two years.

Table 2. Planetary Sidereal Periods

Planet	Geminus	Cleomedes	Simplicius	Modern
Mercury	1 ^y	1 ^y	1 ^y	88 ^d
Venus	1 ^y	1 ^y	1 ^y	224.7 ^d
Mars	2 ^y 6 ^m	2 ^y 5 ^m	2 ^y	687 ^d
Jupiter	12 ^y	12 ^y	12 ^y	11.86 ^y
Saturn	30 ^y	30 ^y	30 ^y	29.46 ^y

The claim that the sidereal periods of Venus and Mercury are each 1 year is found as early as Plato, *Resp.* 617a4–b4 and *Tim.* 38d2–4. It is interesting that P. Par. 1 col. 5 reports the same values as Simplicius for the periods of Mars, Jupiter, and Saturn. Yet, as Neugebauer [1975, 688] remarks, since these values for the outer planets are so widely accepted, we should draw no conclusion about the connection between Simplicius' commentary and the papyrus.

Note that the modern values for the sidereal periods are defined for the planet as seen from the Sun, whereas, for the ancients, the sidereal periods were those observed by an observer on Earth. When one converts Ptolemy's hypotheses for these planets by putting the Sun at the center of the epicycle (rather than on the line from the Earth through this center), treats the Sun as the center of a circle on which the Earth revolves (thus producing a heliocentric hypothesis), and then computes the mean sidereal periods from the period relations given in *Alm.* 9.3, one gets modern values.¹³¹

COMMENT 12.19

IN DE CAELO 495.29 150n194

The Particle «πως»

The indefiniteness of «πως» ('somehow', 'in some way') often shades into uncertainty ('presumably', 'I suppose'). Thus, this particle, when combined with the demonstrative adverb «ὧδε» serves to indicate varying sorts of distance between the speaker and what he is going to say. When one looks at the nine occurrences of «ὧδέ πως» in Simplicius' authentic writings, it is apparent that there are some instances in which this distance is wholly an artifact of urbanity and that it does not signify any real indefiniteness

¹³¹ Cf. Goldstein 2002, esp. 230. See Toomer 1984, 669–672 for discussion of Ptolemy's derivation of his parameters for the planetary mean motions.

or uncertainty at all. His usage of «ὥδέ πω» in introducing quotations is of this sort.¹³² Similar to these occurrences is the one in which Simplicius introduces what is effectively a paraphrase rather than a quotation.¹³³ In neither case does the usage of «πω» translate easily into contemporary English precisely because it is an alien form of polite expression.¹³⁴

But, when «ὥδέ πω» introduces what is not a quotation or paraphrase, «πω» has real force. On one occasion, it is indefinite in that it presents what follows as *a* way of doing or accomplishing something; and so it simply means 'in a way as follows'.¹³⁵ The implication that what follows could be formulated differently to make the same general point is, I think, real. This leaves two instances in which «πω» in «ὥδέ πω» *may* go farther than this by suggesting uncertainty. After all, this is possible at Diels 1882–1895, 524.21 and, as I shall argue, likely at 495.29.¹³⁶

Up to 495.29, Simplicius has interpreted Aristotle's account in *Meta.* Λ.8 of the reportedly Eudoxan view of the homocentric models for the Sun, Moon, and of the first two motions of the five planets, by supplementing this account with information not found in Aristotle's text itself; and he has done this confidently, with no sign of reservation. At 495.29, however, «πω» in «ὥδέ πω ἔχουσιν» would seem to signal a measure of uncertainty in making sense of what Aristotle reports about the motion of the last two planetary spheres.

The alternative view that «πω» entails that what follows is but one account among others which Simplicius knows of or believes possible is implausible: though Simplicius does mention divergent accounts of *Meta.* Λ.8, this comes later and seems restricted to the question of the unwinding spheres.¹³⁷ Certainly, the criticism of the hippopede generated by the third and fourth spheres at 497.5 concerns whether the hippopede duly represents the planet's motion in latitude, and not whether a hippopede is generated in the first place as Simplicius has explained.

¹³² See 104.5, 505.30: cf. Kalbfleisch 1907, 121.13, 331.27, 394.12.

¹³³ See Diels 1882–1895, 276.7.

¹³⁴ Cf. Hankinson 2002, 76; Fleet 1997, 30. Mueller's 'At least he says the following sort of thing' [2005, 45] for «λέγει γοῦν ὥδέ πω» [505.30] is misleading.

¹³⁵ See Kalbfleisch 1907, 22.15.

¹³⁶ Cf. «τάχα ἂν ὥδέ πω ἐπιχειροίη» at Diels 1882–1895, 619.20, where «πω» indicates uncertainty and means something like 'I suppose' or 'I presume'. This is the only occurrence of «ὥδέ πω» in the editions of Simplicius' writings and one wonders whether it should be emended to «ὥδέ πω».

¹³⁷ I am overlooking for the moment those accounts which utilize eccentric circles and spheres: cf. 493.11.

Thus, Simplicius’ position is, I take it, that while what follows is not what Aristotle actually said, it is nevertheless a good guess at what he understood. Of course, whether Simplicius is right in this is a critical question.

The preceding comment assumes Heiberg’s text. I should point out, however, that Grosseteste’s ‘Reliquae autem duae hic qualiter habent?’¹³⁸ would seem to translate «πῶς ἔχουσιν;» rather than «ὥδέ πῶς ἔχουσιν» and that the *Fragmentum Toletanum* has ‘Relique autem due sic se habent’¹³⁹ which would seem to translate «ὥδε ἔχουσιν».

COMMENT 12.20

IN DE CAELO 496.6–9

151n199

Values for the Synodic Periods

The values that Simplicius reports for the five planetary synodic periods are roughly those reported by Cleomedes at *Cael.* 2.7.8–10, except in the case of Mars where the difference is substantial.

Table 3. Planetary Synodic Periods

Planet	Cleomedes	Simplicius*	Modern
Mercury	116 ^d	110 ^d	116 ^d
Venus	584	19 ^m	583.9
Mars	780	8 ^m 20 ^d	687
Jupiter	398	≅13 ^m	399
Saturn	378	≅13 ^m	378

*Simplicius does not specify the length of the month.

Clemency Montelle has noted that Cleomedes’ values ultimately derive from Babylonian Goal-Year texts.¹⁴⁰

Note again that the modern definition of the synodic period differs from the ancient in that it is heliocentric: this period is now defined by the configurations of the Earth and some other planet as seen from the Sun.

138

Bossier n.d.a, 177.24–25.

139

Bossier 1975, 3.6.6.

140

Montelle 2007, 478. A planet’s Goal Year is that integral number of (sidereal) years in which it makes its return to the same star *and* in which there is a whole number of synodic events of the same sort. The synodic period is, thus, the result of dividing the Goal Year by the number of synodic events.

I am not aware, however, of any earlier Greek source that reports or entails the same synodic periods as the ones reported by Simplicius.¹⁴¹ But, in a private communication, Montelle has called my attention to a cuneiform tablet, BM 35402, which puts the synodic period for Mars at 6 months and 20 days (\cong 197 days).

152n205 COMMENT 12.21

IN DE CAELO 496.27–28

The Verb «ἤκω»

Ido Yavetz proposes that Simplicius' «πρὸς τοὺς πόλους ... ἤκεν» could plausibly mean 'move toward the poles', and develops a reconstruction in which the planet is no longer on the equator of the fourth sphere.¹⁴² Though the reconstruction is interesting, the linguistic point is quite unlikely. «ἤκω» is, as it were, not a verb of motion but a verb of *having* moved.¹⁴³ Hence, it means that the planet *has* moved to the poles and, therefore, if one considers the verb's aspect, *is present* at the poles. So, in this context, one understands that it *arrives at* or *reaches* the poles. At 501.16, «ἐπὶ τὸ αὐτὸ ἤξει» surely means 'will have come to' or 'will arrive at', given «ἐν πλείονι χρόνῳ»: 'will move towards' simply ruins the argument. At 506.12, «μήπω ... ἤκειν εἰς τὴν Ἑλλάδα» makes good sense if it means 'had not yet come to Greece': 'had not yet moved towards Greece' would be mildly bizarre. There are numerous other occurrence of this verb in Simplicius' writings and, like those of «ἤκω» more generally, they do not support Yavetz' conjecture. Note Grosseteste's 'ad polos ... venit' and Moerbeke's 'ad polos ... pertingeret'.¹⁴⁴

152n209 COMMENT 12.22

IN DE CAELO 497.3

The Hippopede

Curiously enough, the earliest evidence for the use of «ἡ ἵπποπέδη» rather than «ὁ τοῦ ἵππου πέδος» or just «ὁ πέδος» to designate a horse-fetter seems to come in the ninth century AD.¹⁴⁵ So far as I can determine, the earliest ref-

¹⁴¹ See Neugebauer 1975, 782–785 for a survey of values found in ancient sources for the planetary synodic periods.

¹⁴² Yavetz 1998, 231.

¹⁴³ See Smyth 1971, § 1886.

¹⁴⁴ Bossier n.d.a, 178.30–179.1 and Bossier 1975, 3.7.16.

¹⁴⁵ Cf. *Hipp. Berol.* 106.1.

erences to a curve called a hippopede in a mathematical context are found in Proclus' commentary on Euclid's *Elements*. Proclus, who does not mention Eudoxus or anyone else in connection with this curve, presents the hippopede as a spiric section that is interlaced and like a horse's fetter (presumably, the figure 8).¹⁴⁶ The hippopede that Simplicius mentions is often described nowadays as a spherical lemniscate formed by the intersection of a sphere and a straight circular cylinder.¹⁴⁷ See also Figure 12.06(b) [p. 190] for a qualitative derivation which assumes a two-stage procedure for generating the hippopede (first spin the fourth sphere and then, the third sphere).¹⁴⁸

COMMENT 12.23

IN DE CAELO 497.24–504.3

154n214

The Unwinding Spheres

Aristotle's aim in *Meta.* Λ.6–7 is to show that there are immaterial, non-sensible, unmoving/unchanging substances; that these substances are purely active, eternal intellects; and that they are ultimate principles of motion/change in the world. In Λ.8, he argues that there are as many of these ultimate causes or unmoved movers as there are motions in the heavens, and then proposes to determine just how many these are. As Beere rightly points out, this project is an essential supplement to Aristotle's account of physical theory or science of nature,¹⁴⁹ and its real novelty lies in the thesis that this number can be decided in a non-arbitrary, systematic way by consulting astronomical theory.

Obviously, it is important for this project to distinguish between an intrinsic motion, a motion that is forced or imposed, and a resultant motion, since only the former will have its own unmoved mover. For example, consider the question of the diurnal revolution of the planets. If one looks to Plato's *Timaeus*, there would be but one unmoved mover for this, since the motion of the Same (viz. of the celestial sphere) is *imposed* on all the planetary motions beneath the celestial sphere. Now, if one were to focus solely on the

¹⁴⁶ Friedlein 1873, 112.4–5; cf. 126.24–127.3, 128.2–5.

¹⁴⁷ Cf. Neugebauer 1953; Yavetz 1998, 221–225.

¹⁴⁸ Yavetz [1998, 232–233] argues that the text admits another, and perhaps even better, interpretation, and also contends [1998, 233–237] that there are numerous other curves that could count as hippopedes.

¹⁴⁹ Beere 2003, 1–3. I pass over for now the question of the epistemological status of the argument in *Meta.* Λ.8, and whether it is a boundary argument connecting metaphysics and physical theory.

language of *Meta.* 1073b17–32, in which the first sphere of each of the seven planetary systems is said to be the sphere of the fixed stars and to perform its motion, one might expect that the same is true for Aristotle, namely, that he too thinks that the diurnal rotation of the celestial sphere is imposed on the planets.¹⁵⁰ However, in 1073b37–1074a12, when Aristotle comes to forming a single, complete structure of all the celestial motions, he includes the first carrying sphere in the system for each of the seven planets, thereby treating each planet's diurnal revolution as an intrinsic motion and not as an imposed or a resultant motion.

This is surprising and it makes one wonder what has happened to the celestial sphere itself. Moreover, it has the important consequence that the last unwinding sphere of a given planet cannot serve as the first carrying sphere of the planet below precisely because the diurnal rotation of the last unwinding sphere around the celestial axis from east to west is a *resultant* motion. For Aristotle, then, each of the seven diurnal planetary revolutions must have its own unmoved mover,¹⁵¹ and, as Simplicius says, to discount these motions is to depart significantly from his analysis [cf. 503.35–504.3]. So, when Simplicius [506.23–507.8] asks why the celestial sphere was not sufficient for Aristotle, the question perhaps ought to have been, 'Why did Aristotle suppose that the diurnal revolution of each planet was an *intrinsic* motion in the first place?'

When Aristotle assembles the planetary systems into a single structure of nested rotating homocentric spheres,¹⁵² he evidently assumes that a containing sphere can affect a contained sphere (that is, a sphere which has its poles fixed in/on the containing sphere) *only if* the axis of the containing sphere's (resultant) rotation is oblique to the axis of the contained sphere's intrinsic rotation.¹⁵³ Were this not the case, given that the first carrying spheres of the planetary systems all share the axis and motion of the celestial sphere [cf. 494.1–3, 495.20–22], Aristotle would have been obliged to unwind the first carrying sphere of each planetary system, since it is this

¹⁵⁰ Cf. Yavetz 1998, 225.

¹⁵¹ Cf. Beere 2003, 12–14.

¹⁵² On the question of why he does this, see Bechler 1970 which, in spite of some missteps, argues interestingly that Aristotle's aim in assembling the spheres was not to accommodate new phenomena but to preserve the phenomena already addressed by Eudoxus and Calippus in a system that used their hypotheses without introducing a void into the cosmos. Aristotle's aim, as Bechler sees it, was not to develop a unified mechanism in which motion is transmitted from the celestial sphere to the spheres beneath it.

¹⁵³ On the question of friction, see Beere 2003, 9.

sphere which imposes a diurnal rotation on the system's last unwinding sphere. For instance, if the (resultant) diurnal rotation from east to west of Saturn's last unwinding sphere could affect the rotation of Jupiter's first carrying sphere about the same axis, in the same direction, and in the same time interval, the latter sphere would have a resultant motion from east to west about the celestial axis that was twice as fast as the motion of the celestial sphere itself—an adverse outcome for all the lower spheres, to be sure. Yet, Aristotle does not unwind any planet's first carrying sphere.

Furthermore, though Aristotle does not include the celestial sphere in his reckoning in Λ.8, the second ἀπορία of *De caelo* 2.12 requires that this sphere and its motion not be identified with the first carrying sphere of Saturn and its motion. But, if the celestial sphere is to be included in the single structure of homocentric spheres, the only way to do this without introducing an unwinding sphere for the celestial sphere, would be to hold that, given two homocentric spheres rotating in the same direction about the same axis, the containing sphere does not impose any motion on the contained sphere.¹⁵⁴

In an analysis that certainly rewards study, István Bodnár appears to suppose that it is a fundamental or major presupposition of homocentric theory that 'the way revolutions of two consecutive homocentric spheres are combined does not depend on external factors',¹⁵⁵ such as, I take it, the orientation of their axes. It is not clear whose presupposition this is and one should certainly like to see the argument that it is one which Aristotle makes or needs to make. But Bodnár's contention to the effect that the first carrying sphere of Jupiter will have the combined motion of the last two unwinding spheres of Saturn in addition to its own because

once the axis of rotation is not stationary, the rotation around this axis gets transmitted to the embedded sphere, and hence the motion of the innermost sphere, performed under the causal influence of the mover of its own, will be added to the composite motion of the preceding sphere ...

is a misfire, since he fails to distinguish intrinsic, imposed, and resultant motion. The *intrinsic* motion of Saturn's last unwinding sphere is about the poles of the zodiacal circle and in the direction opposite to that of Saturn's second carrying sphere. The *resultant* motion of this last unwinding sphere, however, is a diurnal rotation about the axis of the celestial sphere. This resultant motion, which is the outcome of the motion *imposed* by the sphere

¹⁵⁴ Cf. Bechler 1970, 119–120.

¹⁵⁵ Bodnár 2005, 266–270.

immediately above the last unwinding sphere—a motion that is itself a resultant motion—and its own intrinsic motion, does not affect Jupiter's first carrying sphere because the axis of rotation is the same. In other words, Bodnár takes for granted the evidently false proposition that, for Aristotle, *whenever* the containing sphere and the contained sphere have different axes, the motion of the containing sphere *must* affect the motion of the contained sphere. This would certainly be true in a two-sphere system. But in more complicated structures such as Aristotle envisages, one should look to the resultant motion of the containing sphere and not just to the motion that it imposes because of its intrinsic motion—assuming that one is to 'save' Aristotle's account of the unified structure of celestial motions.

One consequence of this interpretation, then, is that the theorems recounted by Simplicius in Sosigenes' name at 500.5–14 and 500.22–501.2, even if understood as preparatory to the more general remarks in 500.15–24 and 501.2–11 respectively, are nevertheless problematic, since they take for granted that the outer of two rotating homocentric spheres with a common axis will affect the motion of the inner sphere when they rotate in the same direction.¹⁵⁶

The actual count of the motions and, hence, of the unmoved movers was controversial. To judge from what Simplicius writes, most commentators understood how Aristotle reached 55, though some were troubled that this entailed counting seven motions that were the same as the motion of the celestial sphere. (None apparently inquired about what had happened to the celestial sphere itself.) Moreover, their main difficulty, it seems, was figuring out how Aristotle got 47 in a way that did not contravene sense or basic tenets; and the best that they came up with was the suggestion that the '47' was a scribal error.

Yet, the simplest explanation of that number involves noticing Hipparchus' doubt that Eudoxus actually did posit a third solar motion,¹⁵⁷ and conceding that Aristotle could in fact countenance removing this third sphere for the Sun in addition to the two spheres for the Sun and for the Moon added by Callippus. This would, of course, entail removing three of the unwinding spheres which Aristotle himself adds. And, thus, there would be 47 spheres in all.¹⁵⁸

¹⁵⁶ For discussion of Alexander's remark in *Quaestio* 1.25 [see Bruns 1887, 40.23–30: cf. Sharples 1992, 85] about the diurnal motion of the heavenly bodies below the celestial sphere, see Bodnár 1997.

¹⁵⁷ See Comment 12.12, pp. 262–264.

¹⁵⁸ T.H. Martin [1881, 268] agrees that Aristotle certainly *could* have proposed this and even

It is curious that this solution did not strike Simplicius, given what he writes at 493.23–31 and 501.12–21. It would hardly have been the first instance in which he departs from a strict reading of Aristotle's texts. In any case, there is ample evidence suggesting that Aristotle himself held that the Sun actually has but two motions. See:

- *Meta.* 1072a9–18, where it is argued that the ultimate cause of corruption and generation must have two motions;
- *Meta.* 1072a21–24, where it is clear that this cause is not the celestial sphere but a wandering star; and
- *De gen. et corr.* 336a15–b24 which identifies these two motions as the daily rotation and the motion along the oblique circle (κατὰ τὸν λοξὸν κύκλον: *scil.* the zodiacal circle), and the wandering star as the Sun.¹⁵⁹

COMMENT 12.24

IN DE CAELO 498.5–10 155n217

An Emendation

In Heiberg's text, «ἵνα τε θέσις ... ὑπάρχοι» is in apposition and spells out «δυοῖν ἕνεκα». The phrase «ἔδει ... περιστρέφεσθαι», which is meant to explain the preceding sentence, is problematic. Mueller offers:

For it was necessary both that a sphere move in the same way as the sphere of the fixed stars or as some other sphere around the same axis as it and that it rotate in equal time. [2005, 37]

but this misrepresents the Greek to make sense of it. The core of the problem is «ἢ ἄλλῃ τινὶ σφαίρᾳ» ('or to any other sphere') [498.7]. This phrase adds nothing sensible to the argument, which works perfectly without it. Indeed, the phrase may derive from a marginal comment which crept into the text early in its transmission: that is, perhaps a reader mindful of 487.4–10 wrote «καὶ ἄλλῳ τινί» in the margin and later copyists incorporated this into the text and 'corrected' it.¹⁶⁰ Or, again, it may derive from a marginal comment «ἢ ἄλλῃ τινί» meant to include spheres that share in the diurnal rotation as

asserts that he *ought* to have proposed it. Dryer [1906, 114n2] regards this as the simplest explanation, but doubts that Aristotle had this in mind. Heath [1913, 220n1] allows that it is possible that Aristotle had this in mind, but is persuaded that he lacked the knowledge needed to make this improvement.

¹⁵⁹ Cf. *Meteor.* 1.9, 2.4; *De caelo* .289a26–35.

¹⁶⁰ Grosseteste [Bossier n.d.a, 180.17–18] has 'vel alii alicui' and Moerbeke [Bossier 1975, 3.9.15], 'aut alii alicui'.

a resultant motion but do not have the same axis as the sphere of the fixed stars.¹⁶¹ In any case, it is gratuitous and I propose that it be deleted.¹⁶²

16ln251 COMMENT 12.25

IN DE CAELO 502.10–11

Sosigenes: The Unwinding Spheres

Plainly, Simplicius, on Sosigenes' authority, holds that the agency of the *carrying* spheres is directed downward [498.10–499.3]. But how is one to understand the unwinding spheres?

If we start with Sosigenes/Simplicius' account¹⁶³ of the addition of the fifth sphere [502.2–7], it is striking that the impact of this sphere is said to have been demonstrated. The first question, then, is whether the phrase «τοῦτο γὰρ δέδεικται» [502.6–7] is something that Simplicius has retained from Sosigenes' exposition without actually presenting the demonstration in question or whether it is a reference to the theorems given already in 499.16–500.21. If it is the latter, given that

sphere	<i>A</i>	corresponds to	the third carrying sphere
	<i>DE</i>	—	the fourth carrying sphere
	<i>ZH</i>	—	the fifth (= first unwinding) sphere

it follows initially that:

sphere	3	has the resultant motion	$m_1 + m_2 + m_3$
	4	—	$m_1 + m_2 + m_3 + m_4$

where sphere *p* has an intrinsic motion m_p , and saying that sphere *q* has m_p means that m_p is imposed on sphere *q*. Accordingly, if one adds a fifth sphere with an intrinsic motion opposite to the intrinsic motion of the fourth, the situation changes in this way:

¹⁶¹ See Comment 12.23, pp. 273–277.

¹⁶² Incidentally, Moerbeke [Bossier 1975, 3.9.12–17] construes «ἵνα τε θέσις ... ὑπάρχοι» ('ut situatio ... existat') as two final clauses with «ἔδει ... περιστρέφεσθαι» ('oportebat ... circumvolvi').

¹⁶³ Though it would help to know whether Simplicius' citation of Sosigenes is a quotation, a paraphrase, or a report, this still would not be enough to permit a decision about how much in these citations is due to Simplicius and how much, to Sosigenes. To forestall such concerns while keeping them in view, I will write of Sosigenes/Simplicius in discussing this passage.

sphere	3	has the resultant motion	$m_1 + m_2 + m_3$
	4	—	$m_1 + m_2 + m_3 + m_4$
	5	—	$(m_1 + m_2 + m_3 + m_4 + m_5) = (m_1 + m_2 + m_3),$

since $m_5 = -m_4$. The upshot is that sphere 5, which unwinds the motion of sphere 4, will have the same resultant motion as sphere 3.

Adding a sixth sphere which has an intrinsic motion opposite to that of the third sphere will effect the following:

sphere	2	has the resultant motion	$m_1 + m_2$
	3	—	$m_1 + m_2 + m_3$
	4	—	$m_1 + m_2 + m_3 + m_4$
	5	—	$m_1 + m_2 + m_3$
	6	—	$(m_1 + m_2 + m_3 + m_6) = (m_1 + m_2),$

since $m_6 = -m_3$. And finally, adding a seventh sphere which has an intrinsic motion opposite to the intrinsic motion of the second sphere will accomplish this:

sphere	1	has the intrinsic motion	m_1
	2	has the resultant motion	$m_1 + m_2$
	3	—	$m_1 + m_2 + m_3$
	4	—	$m_1 + m_2 + m_3 + m_4$
	5	—	$m_1 + m_2 + m_3$
	6	—	$m_1 + m_2$
	7	—	$(m_1 + m_2 + m_7) = m_1,$

since $m_7 = -m_2$.

This interpretation is hardly original.¹⁶⁴ In its favor is the fact that it is in accord with the following conditions:

- though the action of the unwinding spheres is imagined to be simultaneous with that of the carrying spheres, this action in either case is to be analyzed sequentially starting with the upper spheres and moving to the lower [cf. 498.1–7];
- the activity of the unwinding spheres should preserve the observed motions of the planet below them; that is, it must be such that the each planetary system as a whole as well as the entire collocation of

¹⁶⁴ See, e.g., Beere 2003, 6–7 and Bowen 2008d, 68n269; cf. Schiaparelli 1925–1927, 2.106.

- carrying and unwinding spheres down to the carrying spheres of the Moon shares in the diurnal rotation only;¹⁶⁵ and
- the activity of the unwinding spheres should likewise not interfere with the observed motions of the last carrying sphere above them.

Yet, I must admit, it does have its challenges. As Taiëb Farhat has communicated to me privately, my earlier proposal to change the text,

κατὰ τὴν αὐτὴν ἐπὶ τῆς πέμπτης κάθετον

at the same perpendicular on the fifth [sphere]

by reading

κατὰ τὴν αὐτὴν ἐπὶ τῆς ἕκτης κάθετον

at the same perpendicular on the sixth [sphere],

is problematic; and I must admit to misgivings myself, given that the text seems sound as it stands: not only are the extant Greek mss in agreement, the indirect witnesses, Grosseteste and Moerbeke, apparently had this reading too in the mss that they consulted.¹⁶⁶ This emendation was predicated on the argument that introducing the fifth sphere in order to unwind the fourth serves to fix the points of the fifth sphere in relation to the third sphere, whereas introducing the sixth sphere serves to fix the points of the sixth in relation to the second sphere, not those of the third and fifth spheres.¹⁶⁷

But, Farhat's counterproposal is, I find, equally problematic. I agree that it is important to observe the steps in which the carrying spheres function and the unwinding spheres are added. But, in explicating this, he also contends that the unwinding spheres act by eliminating the opposed intrinsic motion at its source and thus prevent this intrinsic motion from being imposed downwards.¹⁶⁸ On his construal of the account of the unwinding spheres offered by Sosigenes/Simplicius, then, after adding the fifth sphere, if we ignore the contribution of the intrinsic motion of each unwinding sphere

¹⁶⁵ This will be true, of course, only if, contrary to what is indicated at 500.22–501.1, the motions of spheres which have the same (intrinsic or resultant) axes as well as the same (intrinsic or resultant) periods and directions of rotation are not compounded: see Comment 12.23, pp. 273–277.

¹⁶⁶ Cf. Moerbeke's 'secundum eundem cathetum in quinta' [Bossier 1975, 3.15.16] and Grosseteste's version [Bossier n.d.a, 184.24–25].

¹⁶⁷ Mueller [2005, 41] has 'directly below on the sixth sphere' but does not signal his departure from Heiberg's text.

¹⁶⁸ Cf. 491.17–21 does suggest that only its carrying spheres actually cause a planet to move.

to the resultant motion imposed downwards because the former is directed upwards only, we have:

sphere	3	with the resultant motion	$m_1 + m_2 + m_3$
	4	—	$(m_1 + m_2 + m_3 + m_4 + m_5) = (m_1 + m_2 + m_3)$
	5	—	$m_1 + m_2 + m_3$

since $m_5 = -m_4$. Thus, adding the fifth sphere, that is, a sphere with an intrinsic motion opposite to that of the fourth, serves to fix the fourth in relation to the third. Likewise, since $m_6 = -m_3$, inserting the sixth sphere would have the outcome that:

sphere	2	has the resultant motion	$m_1 + m_2$
	3	—	$(m_1 + m_2 + m_3 + m_6) = (m_1 + m_2)$
	4	—	$(m_1 + m_2 + m_3 + m_6) = (m_1 + m_2)$
	5	—	$(m_1 + m_2 + m_3 + m_6) = (m_1 + m_2)$
	6	—	$m_1 + m_2$

Again, granted that that the intrinsic motion of the sixth sphere is effective upwards only, then, the intrinsic motion of the sixth sphere will fix the third and fifth spheres in relation to the second sphere: as Sosigenes/Simplicius would have it, perpendiculars dropped from the axis of the second sphere will always pass through the same points of the other two spheres, if they pass through them at all. In the same way, since $m_7 = -m_2$, the intrinsic motion of seventh sphere will fix the second and sixth spheres (and with them, of course, the third, fourth, and fifth spheres) in relation to the first:

sphere	1	has the intrinsic motion	m_1
	2	has the resultant motion	$(m_1 + m_2 + m_7) = m_1$
	3	—	$(m_1 + m_2 + m_7) = m_1$
	4	—	$(m_1 + m_2 + m_7) = m_1$
	5	—	$(m_1 + m_2 + m_7) = m_1$
	6	—	$(m_1 + m_2 + m_7) = m_1$
	7	—	m_1

The upshot will be that the entire system of carrying and unwinding spheres moves with one motion, the diurnal rotation of the first sphere, because each sphere below the first is now fixed in relation to it.

But, though such an account of the unwinding spheres renders 502.10–11 easily intelligible, it too has its challenges. In fact, not only does it have the adverse consequence that the demonstration alluded to at 502.6–7 is not included in Simplicius' report of Sosigenes' account, it has the catastrophic

consequence that, while the unwinding motions so construed will rightly not impinge on the system of spheres for the planet immediately below the last unwinding sphere in a planetary system, they will obliterate the motions of all but the first of the carrying spheres above, unless one introduces a scheme for their acting and not acting that allows the carrying spheres to move their planet. There may be a version of this line of interpretation, originating perhaps with Sosigenes, that makes good sense and can deal with such problems. Still, it must be admitted that Simplicius' use of it in explicating *Meta*. A.8 is egregiously inept, if he is in fact relying on it.

Both interpretations broach the problem of the second of Ptolemy's criticisms and whether Ptolemy is not in fact commenting on Sosigenes' explication of homocentric planetary theory. Let me explain. As Simplicius reports at 506.16–22, Ptolemy had two objections to proponents of homocentric hypotheses.¹⁶⁹ The first is that their theory of unwinding spheres introduces a plethora of spheres to accomplish one task, the joint return of the seven planets in relation to the rotation of the fixed sphere. This criticism, which presumably indicates an aesthetic preference for a simpler (that is, non-homocentric) account of planetary motion, focuses on the very purpose for the unwinding spheres, namely, the joint return of the individual motions in each but the very last planetary system so that the resultant motion as a whole is the daily rotation. The second criticism is that in each planetary system that has unwinding spheres, this theory makes the lowest contained or innermost spheres causes (*αἰτίαι*) of the joint return of the spheres above them.

Now, it would seem appropriate in the context of Simplicius' citation at least, to suppose that these *αἰτίαι* (causes) are efficient causes. And, as I gather from Farhat, in the Arabic version of the *Hypoth. plan.*,¹⁷⁰ this is how they are indeed presented. The question is, then, 'In which direction is their causality directed?' Farhat maintains that the unwinding spheres act on the spheres above them, though I have yet to understand how this can work in the quasi-mechanical terms of the theory (if it does or is meant to). Why is the motion imposed by any unwinding sphere not cancelled by the motion of the sphere immediately above, given that the upper sphere has either an intrinsic or a resultant motion that is opposed to it? Or must one also assume that an intrinsic motion can be cancelled only by another intrinsic motion? But, then, how might one make sense of that?

¹⁶⁹ See Kroll 1899–1901, 2.230.3–15 or Proclus' report of these criticisms by Ptolemy.

¹⁷⁰ Cf. Nix 1907, 118.20–31.

In sum, I find the matter unsettled. There is plainly much to be gained by examining book 2 of Ptolemy's *Hypoth. plan.* For instance, armed with knowledge of what the Arabic Ptolemy actually says about homocentric planetary hypotheses, we could decide whether Simplicius has represented the criticism correctly and, if so, perhaps, we might then try to use Ptolemy to explicate what Simplicius says about the unwinding spheres. But this would first require determining whether the Arabic Ptolemy is attacking a theory of homocentric motion propounded to explicate Aristotle's text or whether the target was a theory developed in an independent effort to account for planetary motion as this motion was understood at a much later date. In either case too, it would be very useful to know if this homocentric theory was the one put forth by Sosigenes himself, as Farhat himself maintains, and how this theory compares to the one indicated by Simplicius in his commentary.

But all this lies beyond my competence since I have no Arabic and since, as I have been told by Farhat and others, Nix's translation [1907] of the Arabic version of Ptolemy's treatise is unreliable—to say nothing of the Arabic version itself. So, with this statement of what I take to be the *status quaestionis*, I will close and leave determining the truth in this matter 'for the more vigorous to say'.

COMMENT 12.26

IN DE CAELO 504.24–25 165n269

Aristotherus

Aristotherus is otherwise unknown, except for the assertion made at the end of the anonymous *Vita Arati IV* that Aratus 'was a student of (ἡκουσεν) a certain Aristotherus, an astronomer (μαθηματικός)'.¹⁷¹ This claim about Aratus and Aristotherus is, however, unverifiable. Furthermore, the entry for Aratus in the *Suda*, a lexicon compiled at the end of the 10th century AD, makes no mention of Aristotherus but asserts instead that Aratus was the pupil of Menecrates of Ephesus, a grammarian, and of the philosophers Timon and Menedemus. Admittedly, this entry, so far as it concerns Timon and Menedemus at least, may rest on inferences from other literary sources, specifically, on anecdotal remarks at Diogenes Laertius, *Vitae* 2.133 and 9.113.

¹⁷¹ J. Martin 1974, 21.2. On the history of this text, see J. Martin 1956.

Granted, some scholars regard *Vita Arati IV* as worthless.¹⁷² But there is no reasonable way to decide this in light of the documents available. It is interesting that Heath states only that Aristotherus was *apparently* Aratus' teacher¹⁷³ and that he later abandoned such reticence in maintaining this relation,¹⁷⁴ despite the fact that *Vita Arati IV* was generally dismissed at the time.

165n270 COMMENT 12.27

IN DE CAELO 32.12–33.16Simplicius *versus* Philoponus

As I explained in the Introduction to this volume, one of Simplicius' overriding concerns is to rebut Philoponus' *Against Aristotle on the Eternity of the World* and, in particular, its numerous counterarguments to Aristotle's case for the existence and nature of a fifth simple body, aether.¹⁷⁵ While most of Philoponus' criticisms are dispensed with when they arise early in the commentary, there is one that is merely deflected when it first appears and set aside for a more measured response later when Simplicius comes to *De caelo* 2.12 [see Chapters 1–3]. This criticism not only exposes the challenge facing Simplicius in rescuing Aristotle and his argument for the eternity of the heavens, it draws forth in brief the main lines of his later defense.

According to Simplicius [32.1–11],¹⁷⁶

[32.1] Since Alexander was right,¹⁷⁷ says this man¹⁷⁸ in his seventh chapter, that Aristotle says that motion in a circle is strictly speaking this, namely, [motion]

¹⁷² See, e.g., Mair 1955, 186: cf. Aujac et al. 1979, 9 and n2, for references going back to the 19th century.

¹⁷³ 1913, 222n1: cf. North 1995, 84.

¹⁷⁴ Heath 1921, 1.348: cf., e.g., Dreyer 1906, 141–142. See Bowen 2008a.

¹⁷⁵ See 25.22–26.31 on p. 12: cf. Wildberg 1987, 39–40.

¹⁷⁶ = Wildberg 1987, F7: cf. Rescigno 2004, f8c with 1.178–182.

¹⁷⁷ 32.1–2 εἰ καλῶς ... ἐπέστησεν ὁ Ἀλέξανδρος. This and what follows may be either a quotation or a (close) paraphrase. Given the evidence of Philoponus' other criticisms [see Wildberg 1987], the opening «εἰ» would seem to mean 'since'. The same holds for «εἰ» understood in 32.5 before «οἱ ἀστέρες»: at least, this provides better grounds for Simplicius' speculation about how Philoponus came to know that the heavenly bodies rotate.

¹⁷⁸ 32.1 οὗτος [cf. 32.34]: *scil.* Philoponus. The use of the demonstrative without the name, which is typical of the language of the law-courts and may serve to present Philoponus formally as an opponent, likely indicates strong contempt as well [cf. Wildberg 1991, 107n1], since, for Simplicius, Philoponus had perverted the proper study of philosophical texts [see Wildberg 1999, 115–120]. See Hoffmann 1987, 197–199 on Philoponus' anonymity in Simplicius' polemic.

which is about the center of the universe, yet if all [motions] which are not about [the center] of the universe are strictly speaking neither circular nor simple, and since the [planetary] stars (which perform a motion in accordance with their spheres, as the astronomers¹⁷⁹ think), move about their own centers, neither the [planetary] stars nor their epicycles nor, clearly, the spheres called eccentric perform a motion that is circular or simple strictly speaking, because both downward and upward [motion] are observed. [10] Indeed, even if these [phenomena] conflict, he says, with Aristotle's hypotheses, still, the [planetary] stars evidently have perigees and apogees.¹⁸⁰ [5]

Simplicius begins his response by advancing the idea that circular motion is simple by virtue of its being about *a* center rather than by virtue of its being about the center of the universe, a thesis that requires clarifying Aristotle's commitment to the more restrictive notion of simple circular motion. He then excuses Aristotle from the charge that he erred in warranting or expounding a homocentric theory of planetary motion.

I say, then, that in these [lines]¹⁸¹ Aristotle is only saying this much, that motion in a circle is [motion] about *a* center, since this befits *every* circular motion. But if he elsewhere says that bodies moving in a circle move about the center of the universe, one should understand that he is making his case in accordance with the hypotheses of earlier astronomers.¹⁸² For the Eudoxans/Callippans¹⁸³ (that is, those up to Aristotle who hypothesized turning spheres homocentric to the universe), tried by those means to save the phenomena, saying that all the spheres are about the center of the universe. But [they tried] to explain [the phenomena] in accordance with these hypotheses without mastering the causes of apogees, perigees, apparent direct motions, and retrogradations,¹⁸⁴ that is, [the causes] of the unsmoothnesses apparent in the motions of [the wandering stars]. [20]

For this reason, you know, the Hipparchans (and if there was anyone earlier than [Hipparchus])¹⁸⁵ and, after him, Ptolemy hypothesized eccentric spheres and epicycles, without taking notice through these [new hypotheses] that

¹⁷⁹ 32.6 τοῖς ἀστρονόμοις.

¹⁸⁰ 32.11 ἐναργῶς φαίνονται περίγειοι καὶ ἀπόγειοι γινόμενοι οἱ ἀστέρες: lit. clearly appear (or are observed) at their perigees and apogees. The question here is whether Philoponus has naked-eye observations in mind or ready inference from tabular data.

¹⁸¹ 32.12 ἐν τοῦτοις: *scil. De caelo* 1.2 esp. 268b14–269a9.

¹⁸² 32.15 τῶν πρεσβυτέρων ἀστρονόμων.

¹⁸³ 32.16: for the locution, see 165n268.

¹⁸⁴ 32.20: cf. 135n111 and 134n105.

¹⁸⁵ 32.23 εἴ τις πρὸ τούτου: Simplicius is allowing that there might have been either someone earlier than Hipparchus or a non-Hipparchan contemporary with Hipparchus who hypothesized eccentric spheres and epicycles. Cf. Moerbeke's 'si quis contemporaneus ipsi': Bossier et al. 2004, 44.92.

- [25] all the heavenly bodies move about the center of the universe, but giving in accordance with these hypotheses their explanations of the [phenomena] stated earlier, though they had received explanations [of these phenomena] by [the earlier astronomers].¹⁸⁶

Now, Aristotle says nothing here about these matters; but, in [passages] in which he does say [something], he is evidently following the hypotheses of his predecessors.

- [30] It is clear that differing about these hypotheses is not a matter of reproach, since what is set forth is [the question]: 'By hypothesizing what can the phenomena be saved?' So, it is not at all surprising if different people have tried to save the phenomena on the basis of different hypotheses. If the [wandering] stars move about their own centers, they also move in that they are brought round the [center] of the universe by their spheres.¹⁸⁷

Philoponus has just raised a critical point on which Simplicius agrees, namely, the rejection of Aristotle's homocentric planetary hypotheses. Since it would serve his case no good to bring this to the reader's attention and to explain at this juncture Aristotle's 'real' meaning, Simplicius offers polemic instead: he attacks Philoponus' reasons for holding that all stellar bodies rotate on their own axes. The thrust of his argument is, I presume, that, while *he* has good reason (based on a reading of Plato *and* a proper understanding of Aristotle),¹⁸⁸ Philoponus has none. In this way, Simplicius disengages a more considered response about planetary hypotheses from his direct refutation of Philoponus and allows himself to postpone it until later. In short, Simplicius refuses even to hint that Philoponus may have hit upon a good

¹⁸⁶ 32.26 τὰς ὑπ' ἐκείνων παραλειφθείσας.

¹⁸⁷ In *De caelo* 1.2, Aristotle maintains that there are but two forms of simple motion, motion in a straight line and motion in a circle; and much of his cosmology follows from this. As Simplicius makes clear, Alexander took this to be a fundamental fact in physical theory by construing the center in question to be the center of the universe. Thus, it would follow that motions, when so construed in relation to the same single reference point, can either (a) approach or depart from this point or (b) stay at the same distance from it. Obviously, the simplest form of (a) is motion in a straight line (along a radius), whereas the simplest form of (b) is motion in a circle. (This proposal is presumably intended to give a physical, that is, a non-mathematical, explanation of Aristotle's claim that the straight and the circular are the only simple magnitudes.) All other motions would plainly be composites of these two motions. To Alexander, we may imagine, Simplicius' redefining of circular motion to accommodate motion on an epicycle or eccentric circle as simple motions would undermine the dichotomy that grounds Aristotle's distinction between the sublunary and supralunary elements; and it would effectively put into doubt the validity of the Aristotelian cosmology/physical theory as a fundamental science that does not depend on any other science for the truth of its own hypotheses. Cf. Bowen 2007.

¹⁸⁸ See pp. 27–32.

reason for rejecting Aristotle. As I explain in Chapter 3, Simplicius' preferring non-homocentric planetary hypotheses is in no way meant to impugn Aristotle or the authority of the *De caelo*.¹⁸⁹

The factual claim in his attack is that in Ptolemy's *Canones manuales*, there are included two columns, one giving the location of the epicenter at regular intervals in the planet's sidereal period, and the other listing corrections to these positions that are due to the planet's motion on its epicycle. Simplicius' polemic consists in wondering if Philoponus learned that the planetary bodies move about their own centers or rotate (a thesis that Simplicius endorses) by misinterpreting the second column.

The question, of course, is why Philoponus might have maintained that the heavenly bodies rotate about their own axes in the first place. Perhaps, as Christian Wildberg has pointed out to me, he was thinking that each planet must, like the Moon, perform one rotation in the course of one revolution on its epicycle or, equivalently, during one circuit of its eccentric circle. This would certainly be in accord with Aristotle's 'as for one, so for all' argument in 2.11.

But, then, why does Simplicius mention astronomical tables? If this polemic is not completely absurd, there must be some basis for it. One good possibility is that the polemic springs from the supposition that Philoponus' remark about observing the planets at their apogees and perigees is an inference from tabular data rather than a claim about naked-eye observations.¹⁹⁰ There is no way to confirm this, but it is worth noting that Philoponus reportedly referred to such tables in attacking Proclus and his arguments that the world is eternal.¹⁹¹

From which of the astronomers did this man find out that the [wandering] stars move about their own centers? Did he in fact misunderstand what is in Ptolemy's *Canones*,¹⁹² namely, that there are different numbers for the center of the epicycle and for the [wandering] star itself, and think that the latter numbers are for the motion of the star about its proper center? [That is, did he think this] because he did not know that these [latter] numbers are

[33.1]

¹⁸⁹ See also pp. 10–15.

¹⁹⁰ See Comments 12.28–12.30, 12.32–12.33, pp. 288–291, 291–293.

¹⁹¹ Philoponus mentions an unobservable conjunction of the seven planets in Taurus in AD 529 [Rabe 1899, 579.14–18]. His pupil, Severus Sebokht, offers a fuller account of this which indicates that Philoponus used Ptolemy's *Canones manuales* [see Neugebauer 1959a].

¹⁹² 33.1 Κανόνες: the tables in the *Almagest* were revised with an eye to making them easier to use and published separately as the *Canones manuales*. There is, admittedly, the possibility that Simplicius is referring to the *Almagest*: but see 287n191; Neugebauer 1975, 838–839 and note 6.

- [5] for the star as it changes place [in longitude],¹⁹³ whereas its motion about its center does not occur with its changing place [in longitude]?¹⁹⁴ But the numbers for the center of the epicycle show the motion of the homocentric or eccentric [circle] on which the epicycle moves, whereas the [numbers] for the [wandering] star [show] the motion of the epicycle on which the star moves.¹⁹⁵
- [10] Yet, it is impossible to ascertain the motion of the star itself about its own center [I mean], the length of time in which¹⁹⁶ the star makes a complete rotation, since it does not change from place to place [in longitude] in accordance with this motion. This is why none of the astronomers tried to deduce the complete rotation of the star about its own center, that is, the length of time in which it occurs, since it is not ascertainable. Plato, of course, knew this motion of the [wandering] stars.¹⁹⁷ But what Aristotle believes about the motion of the [wandering stars], he will say in the second [book] of this treatise.
- [15]

165n271 COMMENT 12.28

IN DE CAELO 504.28–29

The Size (Brightness) of Venus and Mars

Simplicius is mistaken: Venus is *invisible* to the naked eye at inferior conjunction, that is, when it is in the middle of its retrograde arc. But even if we allow that he is referring to Venus when it is *near* inferior conjunction, his claim is still badly flawed.

First, a clarification. It is one of the peculiarities of the human eye that when it looks up unaided at point sources of light in the heavens, it construes their brightness as a matter of size. (To appreciate the distinction between their brightness and their size, a distinction which was not actually made until the invention of the telescope, just look at the heavens through a pinhole.) Next, it is important to know that neither the apparent diameter nor the brightness of Venus vary much at all during its synodic period. Indeed, the apparent diameter of Venus varies from 0;0.10° to 0;1° of arc, which is well below the threshold (0;1°) of our ability to discern angular

¹⁹³ 33.5 μεταβαίνοντός ... τοῦ ἀστέρος: *scil.* they are a correction to the motion of the center of the epicycle on the deferent.

¹⁹⁴ 33.6 μεταβαίνοντος αὐτοῦ: Simplicius' point is that the motions are independent, that the rotational motion makes no contribution to the motion in longitude [cf. 33.9–13].

¹⁹⁵ 33.6–8 reading «ἀλλ' οἱ μὲν τοῦ κέντρου ... φέρεται ὁ ἀστήρ». I have not followed Heiberg's punctuation here; instead, I have treated this sentence as a positive statement in its own right and not as part of Simplicius' very rhetorical question [cf. Moerbeke in Bossier et al. 2004, 45.8–10].

¹⁹⁶ 33.10 ἐν πόσῳ χρόνῳ.

¹⁹⁷ 33.13–14: cf. *Timaeus* 40a2–b8.

distance with the naked eye. Further, Venus has phases which compensate its varying distance from Earth so that the magnitude of its brightness ranges only from -3.9 to -4.7 , which is equally difficult to detect.¹⁹⁸

So, given that, in contrast, Mars is visible at the middle of its retrograde arc and that it is noticeably brighter at this point,¹⁹⁹ it seems that Simplicius' thesis here may be no more than a misguided inference based on astronomical theory that postdates Aristotle. After all, no one before Ptolemy appears to have paid any attention to the fact that the stars (both fixed and wandering) differ in size (brightness), if they noticed it at all.²⁰⁰ For his part, in his *Hypotheses planetarum*, Ptolemy puts the five planets at varying distances from the Earth but makes nothing of the variation in size (brightness) that this might entail. Indeed, at one key point, though it surely follows from his hypotheses for Venus, he does not even seem to recognize any variation in its apparent diameter.²⁰¹ It is difficult, then, to hold that prior to the second century AD there was any real concern with the apparent size (brightness) of the five planets, though this claim is essential to Simplicius' 'history'.

Still, Ptolemy does treat Venus and Mars as alike in that he assigns to them very nearly the same ratio of their farthest distance from Earth to their nearest distance. So, one possibility is that, given that size (brightness) *ought* to vary with distance from Earth, Simplicius simply inferred that such variation would be especially noticeable in the case of Venus and Mars because their ratios are roughly 7:1. What is amusing is that he would have been right (albeit accidentally) in the case of Mars and very wrong in the case of Venus, which is significantly unlike Mars in that it is an inner planet—this is why Venus (unlike Mars) has phases and is invisible at the middle of its retrograde arc.

COMMENT 12.29

IN DE CAELO 504.29–30

165n272

Shadows Cast by Venus

The earliest ancient text mentioning shadows cast by Venus seems to be Pliny, *Nat. hist.* 2.37. Recent descriptions of these shadows add little more.²⁰² Though modern computations and observations confirm that Venus does

¹⁹⁸ See Goldstein 1996a, 1–2.

¹⁹⁹ On the brightness of Mars, see Goldstein 1996b.

²⁰⁰ See, e.g., Aristotle, *Meteor.* 343b2–34; Pliny, *Nat. hist.* 2.39.

²⁰¹ See Goldstein 1967, 8b. Al-'Urđi found Ptolemy's treatment of Venus problematic: see Goldstein and Swerdlow 1970, 148 with identification of the author in Saliba 1979.

²⁰² See, e.g., Herschell 1849, 272; Steavenson 1956, 264; Moore 1961, 27.

under certain circumstances cast shadows, one should not assume that Simplicius has himself made such an observation or that he knows anyone who has. He may, after all, be relying solely on literary sources such as Pliny's *Nat. hist.* 2.37.

In general, modern computations and observations serve only to disconfirm ancient observational reports and not to verify them: the reason is that modern science can at best demonstrate that an ancient report is consistent with the natural phenomena. Showing that an ancient report is truly observational requires study of the context in which the report occurs, the aim being to get positive evidence that there actually was an observation. Without such evidence, one should not, for instance, eliminate the possibility that such reports are but adaptations of literary *topoi*, some of which may only be true coincidentally.²⁰³

166n274 COMMENT 12.30

IN DE CAELO 504.30–32

The Size of the Moon

To the learned reader even of Simplicius' time, this argument in support of the thesis that the planets vary in distance to the Earth would not be construed to be about the fact that the Moon (like the Sun) often appears larger (nearer) at the horizon than at the zenith, a phenomenon explained in physical terms by Ptolemy in *Alm.* 1.3,²⁰⁴ but psychologically in his *Optica*,²⁰⁵ as well as by Proclus [*Hyp. ast.* 7.13–15] who follows the account in the *Almagest*. For, if it were about the Moon illusion,²⁰⁶ there would be little point in the subsequent argument, given that observation by means of instruments, as Ptolemy apparently discovered, does *not* confirm the existence of such a variation. (The reader may verify this by looking through a pinhole at the Full Moon when it is at the horizon and at the zenith.)²⁰⁷

So what is Simplicius' point in this argument? If the syntax of his remarks at 504.33 [see 166n275] is a guide, he has doubts that any true variation in the

²⁰³ Cf. 1.4–2.5, 431.30–32.

²⁰⁴ Heiberg 1898–1907, 1.13.3–9; cf. Toomer 1984, 39n24. See also Cleomedes, *Cael.* 2.1.26–44; Bowen and Todd 2004, 101n11.

²⁰⁵ Lejeune 1989, 115.15–116.8.

²⁰⁶ It is called an illusion because it suggests that the Moon's day-circle is not in fact circular.

²⁰⁷ For a very useful discussion of the Moon illusion and of how it has been understood and is still being studied, see Ross and Plug 2002.

Moon's apparent size is in fact discernible by the naked eye. Perhaps, then, he is either still unclear himself about the nature of the Moon illusion, or he is supposing, somewhat tentatively (and wrongly), that the very small variation (putatively) seen with instruments can be seen with the naked eye. In truth, we may have yet again an instance in which Simplicius formulates his expectations based on theory as easy observations.²⁰⁸

COMMENT 12.31

IN DE CAELO 504.33 166n275

Moerbeke: The Digression

Moerbeke's translation of *In de caelo* 2.12 concludes here with the following:

Sic prosequitur Simplicius quod isti non possunt ista causare, sed neque que videntur in eclipsibus; et postea ostendit quod nec Aristoteles firmam reputavit hanc positionem; consequenter ponitypotheses per eccentricos et epiciclos cuius primos inventores dicit fuisse Pythagoricos, quas quia copiosus traduntur a Ptolomeo, non curavi transferre. Deinde movet quasdam obiectiones contra hasypotheses, de quibus dicit alias fore tempus considerandi, et nichil prosequitur de ipsis.

In this way, Simplicius pursues the fact that they cannot explain these [appearances], not even what they observe in eclipses. After that, he shows that not even Aristotle considered this position secure. Accordingly, [Simplicius] posits hypotheses in accordance with eccentric and epicyclic [circles]—he says that the first discoverers of this were the Pythagoreans. (I have not taken care to relate these [hypotheses] because they are handed down rather fully by Ptolemy.) Then, he raises certain objections against these hypotheses, concerning which he says that there will be time to consider others; he does not pursue anything bearing on them. [Bossier 1975, 3.20.1–8]

COMMENT 12.32

IN DE CAELO 504.33–505.1 166n276

The Ancient Digit (δάκτυλος)

Greco-Latin astronomers defined the finger or digit (δάκτυλος) in various ways, some irrelevant in the present context and others at odds with the phenomena. Thus, the digit of eclipse which is $\frac{1}{12}$ the diameter of the

²⁰⁸ For Bate's denial of the claim that atmospheric conditions are identical on the different occasions or in different places, and his rejection of the validity of any claims that a difference in the size of the heavenly bodies has been observed, see Bossier 1987, 319nn41–42.

eclipsed luminary²⁰⁹ is not at issue here; whereas the digit of arc which is $1/12$ of 1° or $1/24$ of a cubit ($= 2^\circ$)²¹⁰ yields a value for the diameter of the Moon that is much too large.²¹¹

Perhaps Simplicius is assuming that the diameter of the lunar disk is 12 digits when the Moon is at its mean distance from the Earth. This type of digit is mentioned elsewhere only in the *De facie* 935d, so far as I know, where Plutarch writes, 'The diameter of the moon measures 12 digits in apparent size at her mean distance.'²¹² Cleomedes, *Cael.* 2.3.15–43²¹³ also asserts that the Moon's diameter is 12 digits but does not specify any distance.²¹⁴

167n280 COMMENT 12.33

IN DE CAELO 505.11–17

An Invisible Variation in Size

Simplicius has thus far proposed that the observable variation in the apparent sizes of the Moon, Venus, and Mars is due to a variation in their distances from the Earth. He then says that such variation ought by rights to be visible in the case of the other planets as well; that is, he supposes that each of the other planets *ought* to evidence a variation in its apparent size that is due to a variation in its distance to the Earth. Allowing for the fact that such variation in apparent size is not perceived, he considers whether the other planets vary *imperceptibly* in size. He concludes that they do, and adduces as proof the fact that these planets vary in their daily motion, that is, in the number of degrees of longitude that each travels day by day. Though he does not say how he knows this in each instance—it is a claim most easily established for the Sun—such variation in a planet's daily progress is, Simplicius assumes, to be explained by positing a variation in its distance from Earth. Thus, Geminus [*Intro. ast.* 1.13–41], for example, supposes that the Sun moves on a circle that is eccentric to the Earth in order to explain the variation in the length of the seasons and the zodiacal months.²¹⁵

²⁰⁹ Cf. Ptolemy, *Alm.* 6.7: Heiberg 1898–1907, 2.500.19–501.1.

²¹⁰ Cf. Neugebauer 1975, 530, 591; Toomer 1984, 322n5.

²¹¹ Aujac et al. [1979, 180n1] assume that the digit in question here is the angular measure; but I see no reason to suppose that Simplicius thinks that the apparent diameter of the Moon is even close to 1° .

²¹² Cherniss 1957, 143.

²¹³ Cf. Bowen and Todd 2004, 131n7.

²¹⁴ For Bate's denial of the claim that there are instruments sufficiently precise to allow the infallible determination of a difference in the apparent size of the heavenly bodies, see Bossier 1987, 319n43.

²¹⁵ But see Comment 12.08, pp. 248–251 on the question of the Sun's distance to Earth.

So far, so good. What is odd, however, is Simplicius' inference from this that there is an imperceptible variation in apparent size. Certainly, neither Geminus nor anyone else who allows that the Sun varies in its distance from Earth claims that there is a perceptible or measurable difference in the Sun's apparent size. Indeed, Ptolemy's theory of eclipses is predicated on the assumption that there is none.²¹⁶ As for the argument at hand, all Simplicius needs is the assertion that planets other than the Moon, Venus, and Mars vary in the distance to the Earth that each stands during the course of its sidereal period too. His attempt to enhance this remark by writing of an *imperceptible* variation in *apparent* size that is caused by a real variation in planetary distance is bizarre and seems at risk of falsely converting the proposition that the variation in a planet's apparent size implies that it has a perigee and an apogee.

COMMENT 12.34

IN DE CAELO 505.21–23

167n282

Homocentric Hypotheses: A History

Polemarchus of Cyzicus is otherwise unknown except for the previous mention at 493.6 [cf. 145n170]. It is striking that, in Simplicius' story, there is first Eudoxus, who sets out to answer Plato's challenge by displaying the planetary phenomena using homocentric hypotheses. (Whether Eudoxus himself recognized that his hypotheses left certain relevant phenomena unaccounted for is not clarified.) Next, there is Aristotle, who, contrary to any evidence in his own extant writings, reportedly recognized the deficiencies of the Eudoxan hypotheses and was not satisfied with these hypotheses, though he nevertheless adopted them. Then, there is Polemarchus, who prefers the homocentric hypotheses, a preference apparently interpreted to involve recognizing one important but recalcitrant 'phenomenon' which he did not think significant. Next, comes Callippus, who tinkered with the homocentric hypotheses in order to accommodate other phenomena with unclear success. (Simplicius [504.19–22] inclines to the possibility that these phenomena included variations in planetary distances). And finally, we have Autolycus, who recognized the recalcitrant phenomenon, thought that it was important, and tried to develop new hypotheses but failed. In short, Simplicius' story may be too good to be true: the 'logical progress' from

²¹⁶ See Neugebauer 1975, 103–104.

positing some hypotheses, adopting these hypotheses with reservations, adopting the same hypotheses but dismissing the reservations, and acknowledging the reservations and tinkering with the hypotheses, to acknowledging the reservations and trying to develop new hypotheses seems more than just a little artificial. Still, it *is* a charming story, albeit one belied by the fact that, so far as we can tell today, no theorist in the fifth to third centuries BC took into account any variation in planetary size (brightness).²¹⁷

168n287 COMMENT 12.35

IN DE CAELO 506.2

Who Cares about the Number of Spheres?

It is customary to take «τοῖς ταῦτα πραγματευομένοις» as a reference to other people.²¹⁸ The problem is the scope of «ταῦτα». It appears to have «τὰ νῦν εἰρημένα» as its antecedent, and thus to be a reference to the determination of the number of the carrying and unwinding spheres. Now, it seems to me unlikely that Aristotle would imagine that this is a project to engage astronomers *per se*—it was obviously not something that he picked up from Eudoxus—or philosophers of another school, say the Platonists. As I understand the text, though Aristotle allows that there may be something to learn from others, presumably astronomers (τὰ δὲ πυνθανομένοις τῶν ζητούντων), he takes for granted that the question of the count is a matter for further research only by members of his own philosophical school, as one might expect given that its context is the project of *Meta.* A. Still, the problem with my translation is that one must supply «λόγους» ('accounts') with «ἀμφοτέροισιν» in 506.2–3.

Of course, however one understands «τοῖς ταῦτα πραγματευομένοις», the underlying question is how this passage and, indeed, the argument of *Meta.* A.8 fits into Aristotle's remarks elsewhere about the various sorts of knowledge and their interrelations. For Aristotle, astronomy is one of the more physical of the sciences that use mathematics. So does his reckoning of the number of unmoved movers in A.8 belong to astronomy, to physical theory more generally, or to metaphysics? The first is unlikely given Aristotle's understanding of what a mathematical science is and how it proceeds [cf. *Phys.* 2.2] and the fact that the items ultimately being counted are understood to be unique substances devoid of matter.

²¹⁷ See Comments 12.07, 12.09, 12.28–30, 12.32–33 [pp. 230–248, 251–259, 288–291, 291–293].

²¹⁸ Cf., e.g., Aujac et al. 1979, 182; Mueller 2005, 45.

Callisthenes and Aristotle

Neugebauer [1975, 608] supposes that these observations concerned eclipses, though there is no such specification in Simplicius' report. In any case, the '31,000' years is a fantasy, based perhaps on a reading of some Babylonian Goal-Year Texts.²¹⁹

As for Callisthenes' sending reports of astronomical observations back to Aristotle, one possibility is that the Babylonian observations which Aristotle mentions at *De caelo* 292a7–9 and *Meteor.* 343b28–30²²⁰ were among those sent back by Callisthenes. Granted, the *De caelo* and *Meteorologica* were at one time thought to antedate Alexander's campaign in Babylonia (–330);²²¹ but such claims are difficult to maintain in the light of what scholars now surmise about the nature and composition of Aristotle's works.²²² Indeed, one should not discount the possibility that the references to the Babylonians were inserted later into the texts that became known as the *De caelo* and *Meteorologica*. Still, such worry is tempered by the additional possibility that Simplicius' report about Callisthenes is no more than an inference based primarily on Callisthenes' relation to Aristotle, Aristotle's demonstrable interest in collecting and analyzing empirical data, and on Aristotle's reference to Babylonian astronomical observations in his treatises.

²¹⁹ Where the extant Greek mss have '31,000',

ἄς ἱστορεῖ Πορφύριος ἐτῶν εἶναι χιλίων καὶ μυριάδων τριῶν ἕως τῶν Ἀλεξάνδρου τοῦ Μακεδόνος σωζομένων χρόνων,

the version of Moerbeke's translation that was published in 1563 has '1903',

quales narrat Porphyrius esse annorum mille et nongentorum trium usque ad tempora Alexandri Macedoni salvatas, [177.col.A]

Though this '1903' might seem more plausible, it is still unwarranted by any evidence that we have today.

²²⁰ See pp. 119, 121n17.

²²¹ Cf., e.g., Ross 1964, 18–19; Rist 1989, 16–17, 284–285.

²²² Cf. Leggatt 1995, 3–4.

169n293 COMMENT 12.37

IN DE CAELO 506.16

Simplicius on Ptolemy

Simplicius' references to Ptolemy are quite complimentary²²³ and indicate good standing in Simplicius' hierarchy of authorities. Simplicius mentions a number of Ptolemy's works, including the *Almagest*, *Geographia*, *Hypotheses planetarum*, *Canones manuales*, and *Optica*.²²⁴

On the interest in Ptolemy's astronomical works shown by Simplicius, and his predecessors, colleagues, and successors in the late Platonic school, see Heiberg 1898–1907, 3.xxxv–xxvii; Heiberg 1894, 462.20–30 with Neugebauer 1975, 1031–1054 and Pingree 1994.

Given Simplicius' frequent citation of Proclus,²²⁵ it seems that Simplicius' understanding of Ptolemaic astronomy, though based perhaps in part on direct acquaintance with Ptolemy's writings, was also dependent on Proclus' writings, particularly Proclus' *Hyp. ast.* and his later commentary on Plato's *Timaeus*.²²⁶

Mendell's reconstructions [1998, 2002] of the solar and lunar theories that Simplicius recounts in his digression, do not, I think, give sufficient weight to Ptolemy's impact on Simplicius' understanding of matters in technical astronomy.

170n295 COMMENT 12.38

IN DE CAELO 506.22

Herophilus and the Nervous System

By Ptolemy's time, there had been substantial advances in the understanding of the anatomy and physiology of the nerves and brain. Indeed, as Galen (129–199/216) and others report, Herophilus (–330/320 to –260/250) was the first to investigate the anatomy of the nerves, and to distinguish motor and sensory nerves.²²⁷ Moreover, he was the first to suppose that the ruling faculty or command center was located in the hind brain (that is, in the cerebellum or fourth ventricle), a view that Galen accepted.²²⁸

²²³ Cf. 9.21 ὁ δὲ θαυμαστός Πτολεμαῖος, 456.23 ὁ ἄριστος τῶν ἀστρονόμων, 710.14 ὁ μαθηματικός.

²²⁴ See Heiberg 1894, 774 s.v. Πτολεμαῖος.

²²⁵ See, e.g., Heiberg 1894, 773 s.v. Πρόκλος.

²²⁶ Cf. Pingree 1994, 89–92 and Comment 10.13, pp. 211–213.

²²⁷ Cf. von Staden 1989, 43–50.

²²⁸ See von Staden 1989, 155–160, 247–259 with textual evidence at 313–319.

On the larger question of the role of medicine in the commentaries on Aristotle's works, see Todd 1984.

COMMENT 12.39

IN DE CAELO 507.12–14 17In302

Simplicius and the Pythagoreans

Simplicius is most likely thinking of the Pythagoreans whom Plato and Aristotle mention in their works: at least, this would make for a proper distinction between the Pythagoreans and 'those who came later' (than Eudoxus, Callippus, Polemarchus, Aristotle, and Autolycus) and whom Simplicius and other late Platonists follow [506.9–10]. At the same time, so understood, it is curious that Simplicius states the claim without comment: though Iamblichus ranks highly in the late Platonist pantheon, this claim about the Pythagoreans runs against Simplicius' own view that it was Plato, not the Pythagoreans, who initiated research concerning hypotheses that might save the planetary phenomena.

As for the claim itself, one possibility is that Nicomachus and with him, Iamblichus, have preserved a fact about these early Pythagoreans that has otherwise been lost. This would mean that, in spite of the preceding demonstration that there are no extant texts prior to the second century requiring us to hold that their authors were aware of planetary stations and retrogradations, the early Pythagoreans *did* indeed possess such knowledge and developed mathematical tools for its analysis. In response to this, let no one deny that Nicomachus and Iamblichus may well have thought that they were talking about the early Pythagoreans. What must be addressed is the assumption that they were right in this and that we should follow them.

In the first place, there *was* a revival of Pythagoreanism during the time of Cicero both in Rome and Alexandria, and this movement was characterized in part by an interest in horoscopic astrology and questions about the motions of the planets. Nigidius Figulus, a friend of Cicero, was, apparently, a leading figure in this movement.²²⁹ Granted, nothing survives of his work except citations in contemporary and later writers,²³⁰ but this still suffices to contextualize his contribution. Others in the movement include Eudorus of

²²⁹ Bowen 2012d.

²³⁰ See O'Meara 1996; Hudson-Williams and Spawforth 1996; Bowen 2007, 332–333. See also Getty 1941 on Figulus' astrological prediction of what was to befall Rome at the outbreak of the Civil War.

Alexandria (active ca 25 BC) and the itinerant holy man, Apollonius of Tyana (first century AD).

Sketchy as this all may be, it is sufficient to challenge the bare assumption that Nicomachus' Pythagoreans were the *early* Pythagoreans rather than the contemporaries of Cicero. Further, even if Nicomachus *meant* the early Pythagoreans, the warrant for this may not have been access to information dating from the fifth and fourth centuries, but to the pseudepigraphic literature written in the late second and first centuries BC, when planetary stations first became known to the Greco-Roman world, which purports to relate the thought of earlier Pythagoreans.²³¹ Indeed, for all we know, Nigidius and his fellow Pythagoreans contributed to this pseudepigraphic literature.

This particular claim about the Pythagoreans is not found in any extant work by either Nicomachus or Iamblichus. But Proclus [*Hyp. ast.* 1.34–35] suggests, on the basis of some unnamed historical account (ὥς ἐκ τῆς ἱστορίας παρειλήφαμεν), that the Pythagoreans came up with the eccentric and epicyclic hypotheses in response to *Pythagoras'* requirement that they seek ways to account for the phenomena using the fewest and simplest hypotheses.

What we would seem to have, then, are competing historical narratives, neither of which is credible given the evidence deriving from early Antiquity.²³² And the differences between them may in fact be due primarily to Simplicius' need to respond to Philoponus in defense of the Late Platonist conviction that the heavens and thus, the cosmos, are uncreated and everlasting.

As for Simplicius' account, it seems that, neither the eccentric nor the epicyclic hypotheses were developed in order to explain any variation in the apparent size (brightness) of the planets. Rather, eccentric hypotheses appear to have been developed in order to account for the different lengths of the seasons and the epicyclic hypotheses, in order to account for the fact that Venus and Mercury are limited in the distance that each travels from the Sun.

²³¹ Cf. Kahn 2001, 72–85. See also Comment 12.09, pp. 258–259.

²³² See Comments 12.07 and 12.09, pp. 230–248 and 251–259.

BIBLIOGRAPHY

PRE-MODERN AUTHORS AND TEXTS

- Agathias of Myrina. *Historiae*. See Keydell 1967.
- Alexander of Aphrodisias. *De anima*. See Bruns 1887.
- . *In Aristotelis meteorologica*. See Hayduck 1899.
- . *Περὶ ἀρχῶν*. See Genequand 2001.
- . *Quaestiones*. See Bruns 1887, Sharples 1992.
- [Alexander of Aphrodisias]. *In Aristotelis metaphysica E–N*. See Hayduck 1891.
- Apianus, P. 1584. *Cosmographia*. Antwerp.
- Aratus. *Phaenomena*. See Mair 1955, Kidd 1997.
- Archimedes. *Arenarius*. Heiberg and Stamatis 1972, 2.215–259.
- Aristarchus. *De magnitudinibus et distantibus solis et lunae*. See Heath 1913.
- Aristotle. *Analytica posteriora*. See Ross and Minio-Paluello 1968.
- . *Analytica priora*. See Ross and Minio-Paluello 1968.
- . *De caelo*. See Allan 1955, Longo 1962, Moraux 1965, Leggatt 1995, Pellegrin and Dalimier 2004.
- . *De generatione et corruptione*. See Rashed 2005.
- . *Fragmenta*. See Ross 1955.
- . *Metaphysica*. See Ross 1953, Tredennick 1933–1935.
- . *Meteorologica*. See Louis 2002.
- [Aristotle]. *Mechanica problemata*. See Hett 1936.
- [Aristotle]. *Physica problemata*. See Louis 1991–1994, Mayhew 2012.
- Autolycus. *Opera et testimonia*. See Aujac, Brunet, and Nadal 1979.
- Cleomedes. *Caelestia*. See Todd 1990, Bowen and Todd 2004.
- Epicurus. *Epistula ad Pythoclem*. See von der Muehl 1922, 27–43.
- Euclid. *Elementa*. See Heiberg and Stamatis 1969–1973.
- . *Optica*. See Heiberg 1895.
- Galenus Grammaticus (Ioannes Galenus Grammaticus). *Allegoriae in Hesiodi theogoniam*. See Flach 1876, 295–365.
- Geminus. *Introductio astronomiae*. See Manitius 1898, Aujac 1975.
- Guilelmus de Moerbeke (William of Moerbeke). 1563. *Simplicii philosophi acutissimi in quattuor libris de caelo Aristotelis noviter fere integro interpretata ac cum fidesimis codicibus graecis recens collata*. Venice.
- . *Aristotelis de caelo et mundo*. See Bossier n.d.b.
- . *Simplicii in Aristotelis de caelo*. See Bossier et al. 2004.
- Hero Alexandrinus. *Mechanica*. See Nix and Schmidt 1900.
- Hipparchus. *In Arati et Eudoxi phaenomena*. See Manitius 1894.
- Hippiatrica Berolensia*. See Oder and Hoppe 1924.
- Iamblichus. *De mysteriis*. See des Places 1966.
- Kepler, J. 1596. *Mysterium cosmographicum*. See Duncan and Aiton 1981.
- MUL.APIN. See Hunger and Pingree 1989.
- Pappus. *Collectio* 7. See Hultsch 1877, Ver Eecke 1982, Jones 1986.

- *In Ptolemaei syntaxin mathematicam*. See Rome 1931–1943.
- Papyrus Parisinus Graecus 1. See Letronne 1865, Blass 1877.
- Philoponus (Ioannes). *De aeternitate mundi contra Proclum*. See Rabe 1899.
- *In Aristotelis physicorum libros commentaria*. See Vitelli 1887–1888.
- Plato. *Leges*. See Burnet 1900–1905, vol. 5.
- *Respublica*. See Slings 2003.
- *Sophistes*. See Burnet 1900–1905, vol. 1.
- *Timaeus*. See Burnet 1900–1905, vol. 4.
- Pliny. *Naturalis historia*. See Mayhoff 1892–1909.
- Plotinus. *Enneades*. See Henry and Schwyzer 1964–1982.
- Plutarch. *De facie in orbe lunae*. See Cherniss 1957.
- *Platonicae quaestiones*. Cherniss 1976.
- *Quaestiones convivales*. See Hubert 1938.
- [Plutarch]. *Placita philosophorum*. See Mau 1971.
- Proclus. *Hypotuposis astronomicarum positionum*. See Manitius 1909.
- *In Platonis rem publicam*. See Kroll 1899–1901.
- *In Platonis Timaeum*. See Diehl 1903–1906.
- *In primum Euclidis elementorum*. See Friedlein 1873.
- Ptolemy. *Almagest*. See Heiberg 1898–1903, Toomer 1984.
- *Hypotheses planetarum*. See Nix 1907, Goldstein 1967, Morelon 1993.
- *Optica*. See Lejeune 1989.
- *Tetrabiblos*. See Robbins 1940.
- Robertus Grossatesta (Robert Grosseteste). *Aristotelis de caelo et mundo cum commentariis Simplicii*. See Bossier n.d.a.
- Sextus Empiricus. *Pyrrhoniae hypotyposes*. See Mutschmann and Mau 1958, Annas and Barnes 2000.
- Simplicius. *In Aristotelis de caelo*. See Heiberg 1894; Aujac, Brunet, and Nadal 1979; Bossier et al. 2004.
- *In Aristotelis physica*. See Diels 1882–1895.
- *In Epicteti encheiridion*. See Hadot 1996.
- Stobaeus (Ioannes). *Anthologium*. See Wachsmuth and Hense 1884.
- Suda*. See Adler 1928–1938.
- Themistius. *In libros Aristotelis de caelo paraphrasis*. See Landauer 1902.
- Theodosius. *Sphaerica*. See Heiberg 1927, Ver Eecke 1959.
- Theon of Smyrna. *De utilitate mathematicae*. See T.H. Martin 1849, Hiller 1878.

MODERN AUTHORS

- Adler, A. 1928–1938. ed. *Suidae lexicon*. 5 vols. Leipzig.
- Allan, D.J. 1955. ed. *Aristotelis de caelo*. Oxford.
- Annas, J. and Barnes, J. 2000. trans. *Sextus of Empiricus: Outlines of Scepticism*. 2nd edn. Cambridge.
- Asmis, E. 1984. *Epictetus' Scientific Method*. Ithaca/London.
- Aujac, G. 1975. ed. and trans. *Géminos*. Introduction aux phénomènes. Paris.
- Aujac, G.; Brunet, J.-P.; and Nadal, R. 1979. ed. and trans. *Autolykos de Pitane*. La sphère en mouvement, Levers et couchers héliques, *Testimonia*. Paris.

- Bagnall, R.S.; Brodersen, K.; Champion, C.B.; Erskine, A.; and Hübner, S. 2012. edd. *The Encyclopedia of Ancient History*. London. (in press)
- Baltussen, H. 2007. 'From Polemic to Exegesis: The Ancient Philosophical Commentary'. *Poetics Today* 28:247–281.
- 2008. *Philosophy and Exegesis in Simplicius: The Methodology of a Commentator*. London.
- Baltzly, D. 2009. 'Gaia Gets to Know Herself: Proclus on the World's Self-Perception'. *Phronesis* 54:261–285.
- Barnes, J. 1975. *Aristotle's Posterior Analytics. Translated with Notes*. Oxford.
- Bechler, Z. 1970. 'Aristotle Corrects Eudoxus: Met. 1073b39–1074a16'. *Centaurus* 15:113–123.
- Beere, J.B. 2003. 'Counting the Unmoved Movers: Astronomy and Explanation in Aristotle's *Metaphysics* XII.8'. *Archiv für Geschichte der Philosophie* 85:1–20.
- Blass, F.W. 1877. *Eudoxi ars astronomica*. Kiel.
- Blomqvist, J. 1969. *Greek Particles in Hellenistic Prose*. Lund.
- Bodnár, I.M. 1997. 'Alexander of Aphrodisias on Celestial Motions'. *Phronesis* 42:190–205.
- 2005. 'Aristotle's Rewinding Spheres: Three Options and Their Difficulties'. *Apeiron* 38:257–275.
- Bolton, R. 2009. 'Two Standards for Inquiry in Aristotle's *De caelo*'. See Bowen and Wildberg 2009, 51–82.
- Bossier, F. n.d.a. ed. *Aristoteles over de hemel, de hemellichamen en de aarde. Het tweede boek van de 'De Caelo' met de commentaren van Simplicius in de latijnse vertaling van R. Grosseteste*. Typescript edition. Aristoteles Latinus Database 8.1.
- n.d.b. ed. *Guillelmus de Moerbeka. Aristotelis de caelo et mundo*. Aristoteles Latinus Database 8.2.
- 1975. *Filologisch-historische navorsingen over die middeleeuwse en humanistische Latijnse vertalingen van den commentaren van Simplicius*. 3 vols. Leuven. Doctoral dissertation.
- 1987. 'Traductions latines et influences du *Commentaire in de caelo* en occident (XIII^e–XIV^e s.)'. See Hadot 1987a, 288–325.
- Bossier, F.; Vande Veire, C.; and Guldentops, G. 2004. ed. *Simplicius. Commentaire sur le traité du ciel d'Aristote. Traduction de Guillaume de Moerbeke*. Leuven.
- Bossier, F. and Steel, C. 1972. 'Priscianus Lydus en de "In de anima" van Pseudo(?)–Simplicius'. *Tijdschrift voor Filosofie* 34:761–822.
- Bosworth, A.B. 1966. 'Callisthenes'. See Hornblower and Spawforth 1996, 278.
- Bouché-Leclercq, A. 1899. *L'astrologie grecque*. Paris.
- Bowen, A.C. 1999. 'The Exact Sciences in Hellenistic Times: Texts and Issues'. Pp. 287–319 in D.J. Furley ed. *Routledge History of Philosophy: 2. From Aristotle to Augustine*. London/New York.
- 2001. 'La scienza del cielo nel periodo pretolemaico'. Pp. 806–839 in S. Petruccioli ed. *Storia della scienza: 1. La scienza antica*. Rome.
- 2002. 'Simplicius and the Early History of Greek Planetary Theory'. *Perspectives on Science* 10:155–167.
- 2003a. 'Eudemus' History of Early Greek Astronomy: Two Hypotheses'. Pp. 307–322 in I.M. Bodnár and W.W. Fortenbaugh edd. *Eudemus of Rhodes*. New Brunswick, NJ.

- 2003b. 'Simplicius' Commentary on Aristotle, *De caelo* 2.10–12: An Annotated Translation (Part 1). *SCIAMVS* 4:23–58.
- 2003c. 'Cleomedes and the Measurement of the Earth: A Question of Procedures'. *Centaurus* 45:59–68.
- 2006. 'Geminus and the Length of the Month: The Authenticity of *Intro. ast.* 8.43–45'. *Journal for the History of Astronomy* 37:193–202.
- 2007. 'The Demarcation of Physical Theory and Astronomy by Geminus and Ptolemy'. *Perspectives on Science* 15:327–358.
- 2008a. 'Aristotheros'. See Keyser and Irby-Massie 2008, 153.
- 2008b. 'Papyrus Parisinus graecus 1 (now P. Louvre 2388 Ro + P. Louvre 2329 Ro)'. See Keyser and Irby-Massie 2008, 622.
- 2008c. 'Sosigenes II'. See Keyser and Irby-Massie 2008, 753.
- 2008d. 'Simplicius' Commentary on Aristotle, *De caelo* 2.10–12: An Annotated Translation (Part 2). *SCIAMVS* 9:25–131.
- 2009. 'Seneca e la delimitazione degli ambiti di studio di musica e filosofia' ('Seneca's Demarcation of the Study of Music and Philosophy'). Pp. 11–20 in D. Castaldo, D. Restani, and C. Tassi edd. *Il sapere musicale come cultura: da Teofrasto a Plutarco*. Ravenna.
- 2012a. 'Callippus of Cyzicus'. In Bagnall et al. 2012.
- 2012b. 'Eudoxus of Cnidus'. In Bagnall et al. 2012.
- 2012c. 'Meton of Athens'. In Bagnall et al. 2012.
- 2012d. 'Nigidius Figulus, Publius (ca 100–45 BCE)'. In Bagnall et al. 2012.
- 2012e. 'Three Introductions to Celestial Science in the First Century BC'. In M. Asper ed. *Writing Science: Medical and Mathematical Authorship in Ancient Greece*. Berlin/New York (in press).
- 2014. 'Hellenistic Astronomy' in P.T. Keyser and J. Scarborough edd. *Oxford Handbook of Science and Medicine in the Classical World*. Oxford/New York (in press).
- Bowen, A.C. and Goldstein, B.R. 1988. 'Meton of Athens and Astronomy in the Late Fifth Century B.C.' Pp. 39–81 in E. Leichty, E. Erle, M. de J. Ellis, and P. Gerardi edd. *A Scientific Humanist: Studies in Memory of Abraham Sachs*. Philadelphia, PA.
- 1991. 'Hipparchus' Treatment of Early Greek Astronomy: The Case of Eudoxus and the Length of Daytime'. *Proceedings of the American Philosophical Society* 135:233–254.
- 1996. 'Geminus and the Concept of Mean Motion in Greco-Latin Astronomy'. *Archive for History of Exact Sciences* 50:157–185.
- Bowen, A.C. and Todd, R.B. 2004. *Cleomedes' Lectures on Astronomy: A Translation of The Heavens with Introduction and Commentary*. Berkeley.
- 2009. 'Heraclides of Pontus on the Motions of Venus and Mercury'. See Fortenbaugh and Pender 2009, 185–204.
- Bowen, A.C. and Wildberg, C. 2009. ed. *New Perspectives on Aristotle's De caelo*. Leiden.
- Bruns, I. 1887. ed. *Alexandri Aphrodisiensis praeter commentaria scripta minora*. Commentaria in Aristotelem Graeca 2.1. Berlin.
- Burnet, J. 1900–1905. ed. *Platonis opera*. 5 vols. Oxford.
- Cameron, A. 1969. 'The Last Days of the Academy at Athens'. *Proceedings of the Cambridge Philological Society* NS 15:7–29.

- Chase, M. 2003. *Simplicius: On Aristotle's Categories 1–4*. Ithaca, NY.
- Cherniss, H.F. 1957. ed. and trans. *Plutarch: Concerning the Face which Appears in the Orb of the Moon*. Cambridge, MA/London.
- 1976. ed. and trans. *Plutarch: Platonic Questions*. Cambridge, MA/London.
- Cornford, F.M. 1966. *Plato's Cosmology: The Timaeus of Plato Translated with a Running Commentary*. London.
- D'Ancona, C. 2007. *The Libraries of the Neoplatonists*. *Philosophia Antiqua* 107. Leiden/Boston.
- Denniston, J.D. 1966. *The Greek Particles*. 2nd edn. Oxford.
- De Santillana, G. 1940. 'Eudoxus and Plato: A Study in Chronology'. *Isis* 32:248–262.
- des Places, E. 1966. ed. *Jamblique. Les mystères d'Égypte*. Paris.
- Dicks, D.R. 1970. *Early Greek Astronomy to Aristotle*. Ithaca, NY.
- Diehl, E. 1903–1906. ed. *Procli Diadochi in Platonis Timaeum commentaria*. 3 vols. Leipzig.
- 1879. ed. *Doxographi graeci*. 4th edn. Berlin.
- Diels, H. 1882–1895. ed. *Simplicii in physicorum libros commentaria*. *Commentaria in Aristotelem Graeca* 9–10. Berlin.
- Dreyer, J.L.E. 1906. *History of the Planetary Systems from Thales to Kepler*. Cambridge.
- Duhem, P. 2003. *Σώζειν τὰ φαινόμενα. Essai sur la notion de théorie physique de Platon à Galilée*. Paris.
- Duncan, A.M. and Aiton, E.J. 1981. trans. *Johannes Kepler: The Secret of the Universe*. New York.
- Easterling, H.J. 1961. 'Homocentric Spheres in the *De caelo*'. *Phronesis* 6:138–153.
- Eastwood, B.S. 1992. 'Heraclides and Heliocentrism: Texts, Diagrams, and Interpretations'. *Journal of the History of Astronomy* 23:233–260.
- Elders, L. 1966. *Aristotle's Cosmology: A Commentary on the De caelo*. Assen.
- Evans, J. 1998. *The History and Practice of Ancient Astronomy*. New York/Oxford.
- Evans, J. and Berggren, J.L. 2006. *Geminus's 'Introduction to the Phaenomena': A Translation and Study of a Hellenistic Survey of Astronomy*. Princeton/Oxford.
- Falcon, A. 2008. *Aristotle and the Science of Nature: Unity without Uniformity*. Cambridge.
- 2012. *Aristotelianism in the First Century BCE: Xenarchus of Seleucia*. Cambridge/New York.
- Festugière, A.J. 1966–1968. trans. *Proclus. Commentaire sur le Timée*. 5 vols. Paris.
- Flach, H. 1876. ed. *Glossen und Scholien zur hesiodischen Theogonie*. Leipzig.
- Fleet, B. 1997. *Simplicius: On Aristotle's Physics 2*. Ithaca, NY.
- Fortenbaugh, W.W.; Huby, P.M.; Sharples, R.W.; and Gutas, D. 1992. edd. and trans. *Theophrastus of Eresus: Sources for His Life, Writings, Thought and Influence*. *Philosophia Antiqua* 54.1–2. 2 vols. Leiden.
- Fortenbaugh, W.W. and Pender, E. 2009. *Heraclides of Pontus: Discussion*. Rutgers University Studies in Classical Humanities 15. New Brunswick, NJ/London.
- Friedlein, G. 1873. ed. *Procli Diadochi in primum Euclidis elementorum librum commentarii*. Leipzig.
- Genequand, C. 2001. *Alexander of Aphrodisias on the Cosmos*. Leiden/Boston.
- Gerson, L.P. 2005. *Aristotle and Other Platonists*. Ithaca, NY.
- Getty, R.J. 1941. 'The Astrology of P. Nigidius Figulus (Lucan I, 649–665)'. *Classical Quarterly* 35:17–22.

- Gill, M.L. 2009. 'The Theory of the Elements in *De caelo* 3 and 4'. See Bowen and Wildberg 2009, 139–161.
- Gillispie, C. 1970–1990. ed. *Dictionary of Scientific Biography*. 18 vols. New York.
- Goldstein, B.R. 1967. ed. and trans. *The Arabic Version of Ptolemy's Planetary Hypotheses*. Transactions of the American Philosophical Society NS 57.4. Philadelphia.
- 1985. *The Astronomy of Levi ben Gerson (1288–1344)*. New York/Berlin.
- 1996a. 'The Pre-Telescopic Treatment of the Phases and Apparent Size of Venus'. *Journal for the History of Astronomy* 27:1–12.
- 1996b. 'Levi ben Gerson and the Brightness of Mars'. *Journal for the History of Astronomy* 27:297–300.
- 2002. 'Copernicus and the Origin of the Heliocentric System'. *Journal for the History of Astronomy* 33:219–235.
- 2009. 'Apollonius of Perga's Contributions to Astronomy Reconsidered'. *Physis* 46:1–14.
- Goldstein, B.R. and Bowen, A.C. 1991. 'The Introduction of Dated Observations and Precise Measurements in Greek Astronomy'. *Archive for History of Exact Sciences* 43:93–132.
- Goldstein, B.R. and Swerdlow, N.M. 1970. 'Planetary Distances and Sizes in an Anonymous Arabic Treatise Preserved in Bodleian Ms. Marsh 621'. *Centaurus* 15:135–170.
- Golitsis, P. 2008. *Les commentaires de Simplicius et de Jean Philopon à la Physique d'Aristote*. Commentaria in Aristotelem Graeca et Byzantina 3. Berlin/New York.
- Grant, R. 1852. *History of Physical Astronomy from the Earliest Ages to the Middle of the Nineteenth Century Comprehending a Detailed Account of the Establishment of the Theory of Gravitation by Newton with an Exposition of the Progress of Research on All Other Subjects of Celestial Physics*. London.
- Guthrie, W.K.C. 1960. trans. *Aristotle: On the Heavens*. Cambridge, MA/London.
- Hadot, I. 1987a. ed. *Simplicius, sa vie, son oeuvre, sa survie*. Berlin/New York.
- 1987b. 'La vie et l'oeuvre de Simplicius'. See Hadot 1987a, 3–39.
- 1987c. 'Recherches sur les fragments du commentaire de Simplicius sur la *Métaphysique* d'Aristote'. See Hadot 1987a, 225–245.
- 1996. *Simplicius. Commentaire sur le Manuel d'Épictète. Introduction et édition critique du texte grec*. Philosophia Antiqua 66. Boston/Leiden.
- Hager, F.P. 1983. 'Zur Geschichte, Problematik, und Bedeutung des Begriffes "Neuplatonismus"'. *Diotima* 11:98–110.
- Hall, J.J. 1971. "'Planets" in Simplicius *De caelo* 471.1 ff.'. *The Journal of Hellenic Studies* 91:138–139.
- Hankinson, R.J. 2002. trans. *Simplicius: On Aristotle's On the Heavens 1.1–4*. Ithaca, NY.
- Hayduck, M. 1891. ed. *Alexandri Aphrodisiensis in Aristotelis metaphysica commentaria*. Commentaria in Aristotelem Graeca 1. Berlin.
- 1899. ed. *Alexandri Aphrodisiensis in Aristotelis meteorologicorum libros commentaria*. Commentaria in Aristotelem Graeca 3.2. Berlin.
- 1904. ed. *Michaelis Ephesii in libros de partibus animalium, de animalium motione, de animalium incessu commentaria*. Commentaria in Aristotelem Graeca 22.2. Berlin.
- Heath, T.L. 1913. *Aristarchus of Samos: The Ancient Copernicus*. Oxford.
- 1921. *A History of Greek Mathematics*. 2 vols. Oxford.

- Heglmeier, F. 1996. 'Die griechische Astronomie zur Zeit des Aristoteles: ein neuer Ansatz zu den Sphärenmodellen des Eudoxus und des Kallippos'. *Antike Naturwissenschaft und ihre Rezeption* 6:51–72.
- Heiberg, J.L. 1894. ed. *Simplicii in Aristotelis de caelo commentaria*. Commentaria in Aristotelem Graeca 7. Berlin.
- 1895. ed. *Euclidis opera omnia*. vol. 7. Leipzig.
- 1898–1903. ed. *Claudii Ptolemaei opera quae exstant omnia: 1. Syntaxis mathematica*. Leipzig.
- 1907. ed. *Claudii Ptolemaei opera quae exstant omnia: 2. Opera astronomica minora*. Leipzig.
- 1927. ed. *Theodosius Tripolites*. Sphaerica. Berlin.
- Heiberg, J.L. and Stamatis, E.S. 1969–1973. edd. *Euclides*. Elementa. 4 vols. Leipzig.
- 1972–1975. edd. *Archimedis opera omnia cum commentariis Eutocii*. 4 vols. Leipzig.
- Heiberg, J.L. and Zeuthen, H.G. 1929. edd. *Paul Tannery. Mémoires scientifiques*. vol. 9. Paris.
- Henry, P. and Schwyzer, H.-R. 1964–1982. ed. *Plotini opera*. 3 vols. Oxford.
- Herschell, J.F.W. 1849. *Outlines of Astronomy*. Philadelphia.
- Hett, W.S. 1936. trans. *Aristotle: Mechanical Problems*. Cambridge, MA/London.
- Hiller, E. 1878. ed. *Theonis Smyrnaei philosophi platonici expositio rerum mathematicarum ad legendum Platonem utilium*. Leipzig.
- Hoffmann, P. 1987. 'Simplicius' Polemics: Some Aspects of Simplicius' Polemical Writings against John Philoponus: From Invective to a Reaffirmation of the Transcendancy of the Heavens'. Pp. 57–83 in R.R.K. Sorabji ed. *Philoponus and the Rejection of Aristotelian Science*. London. Revised version: 'Sur quelques aspects de la polémique de Simplicius contre Jean Philopon. De l'invective à la réaffirmation de la transcendance du ciel'. See Hadot 1987a, 183–221.
- 2000. 'Bibliothèques et formes du livre à de l'antiquité. Le témoignage de la littérature néoplatonicienne des Ve et VIe siècles'. See Prato 2000, 2.601–632. Partial repr. in D'Ancona 2007, 135–153.
- Hornblower, S. and Spawforth, A.J.S. 1996. edd. *The Oxford Classical Dictionary*. 3rd edn. Oxford/New York.
- Hubert, C. 1938. ed. *Plutarchi quaestiones convivales*. Leipzig.
- Huby, P.; Steel, C.; Urmson, J.O.; and Lautner, P. 1997. *Priscian, On Theophrastus' On Sense-Perception, with Simplicius' On Aristotle's On the Soul 2.5–12*. Ithaca, NY.
- Hudson-Williams, A.H. and Spawforth, A.J.S. 1996. 'Nigidius Figulus, Publius'. See Hornblower and Spawforth 1996, 1044.
- Hultsch, F. 1877. ed. and trans. *Pappi Alexandrini collectio*. vol. 2. Berlin.
- Hunger, H. and Pingree, D. 1989. *MUL.APIN: An Astronomical Compendium in Cuneiform*. Horn, Austria.
- Hunger, H.; Reade, J.; and Parpola, S. 1992. *Astrological Reports to Assyrian Kings*. State Archives of Assyria 8. Helsinki.
- Johansen, T.K. 2009. 'From Plato's *Timaeus* to Aristotle's *De caelo*: The Case of the Missing World Soul'. See Bowen and Wildberg 2009, 9–28.
- Jones, A. 1986. ed. and trans. *Pappus of Alexandria: Book 7 of the Collection*. New York/Berlin.

- 1999. 'Geminus and the Isia'. *Harvard Studies in Classical Philology* 99:255–267.
- 2000. 'Studies in the Astronomy of the Roman Period: 4. Solar Tables Based on a Non-Hipparchian Model'. *Centaurus* 42:77–88.
- 2004. 'An *Almagest* before Ptolemy's?' Pp. 129–136 in C. Burnett, J.P. Hogendijk, K. Plofker, and M. Yano edd. *Studies in the History of the Exact Sciences in Honour of David Pingree*. Leiden/NewYork/Köln.
- 2006. 'The Keskintos Astronomical Inscription: Text and Interpretations'. *SCIAMVS* 7:3–41.
- Kahn, C.H. 2001. *Pythagoras and the Pythagoreans: A Brief History*. Indianapolis/Cambridge, MA.
- Kalbfleisch, K. 1907. ed. *Simplicii in Aristotelis categorias commentarium*. Commentaria in Aristotelem Graeca 8. Berlin.
- Karamanolis, G. 2006. *Plato and Aristotle in Agreement? Platonists on Aristotle from Antiochus to Porphyry*. Oxford.
- Keydell, R. 1967. *Agathiae Myrinaei historiarum libri quinque*. Corpus Fontium Historiae Byzantinae 2. Berlin.
- Keyser, P.T. and Irby-Massie, G.L. 2008. edd. *The Encyclopedia of Ancient Natural Scientists*. London.
- Kidd, D. 1997. *Aratus: Phaenomena Edited with Introduction, Translation and Commentary*. Cambridge Classical Texts and Commentaries 34. Cambridge.
- Kidd, I.G. 1988–1999. ed. and trans. *Posidonius*. 3 vols/4 tomes. Cambridge. Vol. 1 was edited with L. Edelstein.
- Kirk, G.S.; Raven, J.E.; and Schofield, M. 1983. *The Presocratic Philosophers: A Critical History with a Selection of Texts*. Cambridge.
- Knorr, W.R. 1990. 'Plato and Eudoxus on the Planetary Motions'. *Journal for the History of Astronomy* 21:313–329.
- Kroll, W. 1899–1901. ed. *Procli Diadochi in Platonis rem publicam commentaria*. 2 vols. Leipzig.
- Landauer, S. 1902. ed. *Themistii in libros Aristotelis de caelo paraphrasis hebraice et latine*. Commentaria in Aristotelem Graeca 5. Berlin.
- Lasserre, F. 1966. *Die Fragmente des Eudoxos von Knidos*. Berlin.
- Leggatt, S. 1995. trans. *Aristotle: On the Heavens I and II*. Warminster, England.
- Lejeune, A. 1989. *L'Optique de Claude Ptolémée dans la version latine d'après l'arabe de l'émir Eugène de Sicile. Édition critique et exégétique augmentée d'une traduction française et de compléments*. Leiden/New York.
- Lennox, J.G. 2009. 'De caelo 2.2 and Its Debt to *De incessu animalium*'. See Bowen and Wildberg 2009, 187–214.
- Letronne, M. 1865. 'Traité d'astronomie d'après Eudoxe'. *Notices et extraits des manuscrits de la Bibliothèque impériale* 18.2:25–76.
- Leunissen, M.E.M.P.J. 2009. 'Why Stars Have No Feet: Explanation and Teleology in Aristotle's Cosmology'. See Bowen and Wildberg 2009, 215–237.
- Liddell, H.G.; Scott, R.; and Jones, H.S. 1968. *A Greek-English Lexicon*. Oxford.
- Lloyd, A.C. 1990. *The Anatomy of Neoplatonism*. Oxford.
- Lloyd, G.E.R. 1991. *Methods and Problems in Ancient Science*. Cambridge.
- Longo, O. 1962. ed. and trans. *Aristotele. De caelo*. Florence.
- Louis, P. 1991–1994. ed. and trans. *Aristote. Problèmes*. Paris.
- 2002. ed. and trans. *Aristote. Météorologiques*. Paris.

- Luna, C. 2001. *Trois études sur la tradition des commentaires anciens à la Méta-physique d'Aristote*. Philosophia Antiqua 88. Boston/Leiden.
- Mair, G.W. 1955. *Aratus*. London.
- Manitius, C. 1894. *In Arati et Eudoxi phaenomena commentariorum libri tres*. Leipzig.
- 1898. ed. *Gemini elementa astronomiae*. Leipzig. Repr. 1974. Stuttgart.
- 1909. ed. *Procli Diadochi hypotuposis astronomicarum positionum*. Stuttgart.
- Martin, J. 1956. *Histoire du texte des phénomènes d'Aratos*. Paris.
- 1974. ed. *Scholia in Aratum vetera*. Leipzig.
- Martin, T.H. 1849. ed. and trans. *Theonis Smyrnaei platonici liber de astronomia cum Sereni fragmento*. Paris.
- 1881. *Mémoire sur l'histoire des hypothèses astronomiques chez les grecs et les romains. Première partie: Hypothèses astronomiques des grecs avant l'époque alexandrine*. Mémoires de l'Institut National de France, Académie des Inscriptions et Belles-Lettres 30.1. Paris.
- Mastorakou, S. 2007. *Hellenistic Popular Astronomy: Aratus' Phaenomena*. PhD Dissertation, Imperial College, University of London. London.
- Matthen, M. 2009. 'Why Does the Earth Move to the Center? An Examination of Some Methodological Strategies in Aristotle's Cosmology'. See Bowen and Wildberg 2009, 119–138.
- Mau, J. 1971. ed. *Plutarchi moralia*. vol. 5.2.1. Leipzig.
- Maula, E. 1974. *Studies in Eudoxus' Homocentric Spheres*. Commentationes Humanarum Litterarum 50. Helsinki.
- Mayhew, R. 2007. 'Aristotle on Prayer'. *Rhizai* 4:295–309.
- 2012. ed. and trans. *Aristotle: Problems*. 2 vols. Cambridge, MA/London.
- Mayhoff, C. 1892–1909. ed. *C. Plinii secundi naturalis historiae libri XXXVII*. Leipzig.
- Mendell, H. 1998. 'Reflections on Eudoxus, Callippus, and Their Curves: Hippopedes and Callippopedes'. *Centaurus* 40:177–275.
- 2000. 'The Trouble with Eudoxus'. Pp. 59–138 in P. Suppes, J.M. Moravcsik, and H. Mendell edd. *Ancient and Medieval Traditions in the Exact Sciences: Essays in Memory of Wilbur Knorr*. Stanford, CA.
- Moore, P. 1961. *The Planet Venus*. London/New York.
- Morau, P. 1954. 'Notes sur la tradition indirecte du "de Caelo" d'Aristote'. *Hermes* 82:145–182.
- 1965. ed. *Aristote. Du ciel*. Paris.
- 1970. *D'Aristote à Bessarion. Trois exposés sur l'histoire et la transmission de l'aristotélisme grec*. Montreal.
- Morelon, R. 1993. ed. and trans. 'Le traité 1 du *Livre des hypothèses* de Ptolémée'. *Mideo* 21:7–85.
- Mueller, I. 2004a. *Simplicius: On Aristotle's On the Heavens 2.1–9*. Ithaca, NY.
- 2004b. 'Remarks on Physics and Mathematical Astronomy and Optics in Epicurus, Sextus Empiricus, and Some Stoics'. Pp. 57–87 in P. Lang ed. *Re-Inventions: Essays on Hellenistic and Early Roman Science*. Apeiron 37.4. Kelowna, BC.
- 2005. *Simplicius: On Aristotle's On the Heavens 2.10–14*. Ithaca, NY.
- Musatti, C.A. 2006. rev. Bossier et al. 2004. *Quaestio* 6:524–532.
- Mutschmann, H. and Mau, J. 1958. edd. *Sexti Empirici opera*. vol. 1. Leipzig.
- Neugebauer, O. 1953. 'On the "Hippopede" of Eudoxus'. *Scripta Mathematica* 19:225–229.

- 1955. 'Apollonius' Planetary Theory'. *Communications on Pure and Applied Mathematics* 8:641–648.
- 1959a. 'Regula Philippi Arrhidaeii'. *Isis* 50:477–478.
- 1959b. 'The Equivalence of Eccentric and Epicyclic Motion according to Apollonius'. *Scripta Mathematica* 24:5–21.
- 1975. *A History of Ancient Mathematical Astronomy*. Berlin/Heidelberg/New York.
- Newton, R.R. 1972. *Medieval Chronicles and the Rotation of the Earth*. Baltimore/London.
- Nix, L. 1907. *Ptolemaei hypoth. plan. liber β' interpretatus ex arabico*. See Heiberg 1907, 109–145.
- Nix, L. and Schmidt, W. 1900. edd. *Heroni Alexandrini opera quae supersunt omnia*. vol. 2.1. Leipzig.
- North, J.D. 1995. *The Norton History of Astronomy and Cosmology*. New York/London.
- Oder, E. and Hoppe, K. 1924. *Corpus hippiatricorum graecorum*. Leipzig.
- O'Meara, D.J. 1989. *Pythagoras Revived: Mathematics and Philosophy in Late Antiquity*. Oxford.
- 1996. 'Neopythagoreanism'. See Hornblower and Spawforth 1996, 1035–1036.
- Parpola, S. 1970–1983. *Letters from Assyrian Scholars to the Kings Esarhaddon and Assurbanipal*. Alter Orient und Altes Testament 5.1–2. Neukirchen-Vluyn.
- Parpola, S. and Reade, J. 1993. *Letters from Assyrian and Babylonian Scholars*. State Archives of Assyria 10. Helsinki.
- Pellegrin, P. 2009. 'The Argument for the Sphericity of the Universe in Aristotle's *De caelo*: Astronomy and Physics'. See Bowen and Wildberg 2009, 163–185.
- Pellegrin, P. and Dalimier, C. 2004. *Aristote. Traité du ciel*. Paris.
- Pingree, D. 1994. 'The Teaching of the *Almagest* in Late Antiquity'. Pp. 75–98 in T.D. Barnes ed. *The Sciences in Greco-Roman Society*. *Apeiron* 27.4.
- Praechter, K. 1906. rev. Hayduck 1904. *Göttingische gelehrte Anzeigen* 168:861–907.
- Prato, G. 2000. *I manoscritti greci tra riflessione e dibattito*. Papyrologica Florentina 31. Florence.
- Price, D.J. 1957. 'Precision Instruments to 1500 with a Section (VII) on Hero's Instruments by A.G. Drachmann'. Pp. 582–619 in vol. 3 of C.J. Singer et al. edd. *A History of Technology*. Oxford.
- Rabe, H. 1899. ed. *Ioannes Philoponus. De aeternitate mundi contra Proclum*. Leipzig.
- Rashed, M. 2005. ed. and trans. *Aristote. De la génération et de la corruption*. Paris.
- Rehm, A. 1949. 'Parapegma'. 18.4: cols 1295–1366 in A. Pauly, G. Wissowa, W. Kroll, et al. edd. *Paulys Real-Encyclopädie der classischen Altertumswissenschaft*. 1894–. Stuttgart.
- Remes, P. 2008. *Neoplatonism*. Berkeley/Los Angeles.
- Rescigno, A. 2004–2008. *Alessandro di Afrodisia. Commentario al de caelo di Aristotele. Frammenti del primo libro*. 2 vols. Amsterdam.
- Rist, J.M. 1985. 'The End of Aristotle's *On Prayer*'. *American Journal of Philology* 106:110–113.
- 1989. *The Mind of Aristotle: A Study on Philosophical Growth*. Toronto.
- Robbins, F.E. 1940. ed. and trans. *Ptolemy: Tetrabiblos*. London.
- Robinson, R. 1966. *Plato's Earlier Dialectic*. 2nd edn. Oxford.

- Rome, A. 1931–1943. *Commentaires de Pappus et de Théon d'Alexandrie sur l'Almageste*. 3 vols. Rome.
- Ross, H.E. and Plug, C. 2002. *The Mystery of the Moon Illusion: Exploring Size Perception*. Oxford/New York.
- Ross, W.D. 1953. *Aristotle's Metaphysics: A Revised Text with Introduction and Commentary*. 2 vols. Oxford.
- 1955. ed. *Fragmenta selecta*. Oxford.
- 1964. *Aristotle*. London/New York.
- Ross, W.D. and Minio-Paluello, L. 1968. edd. *Aristotelis analytica priora et posteriora*. Oxford.
- Sachs, A. and Hunger, H. 1989. edd. *Astronomical Diaries and Related Texts from Babylonia*. vol. 1. Österreichische Akademie der Wissenschaften: Philosophisch-historische Klasse Denkschriften 195. Vienna.
- Saliba, G. 1979. 'The First Non-Ptolemaic Astronomy at the Maraghah School'. *Isis* 70:571–576.
- Savoie, D. 2003. 'Problèmes de datation d'une occultation observée par Aristote'. *Revue d'histoire des sciences* 56:493–504.
- Schiaparelli, G. 1925–1927. *Scritti sulla storia dell' astronomia antica*. 3 vols. Bologna.
- Sedley, D. 1989. 'Philosophical Allegiance in the Greco-Roman World'. Pp. 97–119 in M. Griffin and J. Barnes edd. *Philosophia Togata: Essays in Philosophy and Roman Society*. Oxford.
- Sharples, R.W. 1976. 'Responsibility and the Possibility of More than One Course of Action: A Note on Aristotle *De caelo* II.12'. *Bulletin of the Institute of Classical Studies* 23:69–72.
- 1992. *Alexander of Aphrodisias: Quaestiones 1.1–2.15*. Ithaca, NY.
- Slings, S.R. 2003. ed. *Platonis respublica*. Oxford.
- Smith, A. 1996. 'Porphyry'. See Hornblower and Spawforth 1996, 1226.
- Smyth, H.W. 1971. *Greek Grammar. Revised by G.W. Messing*. Cambridge, MA.
- Sorabji, R.R.K. 1996. 'Philoponus, John'. See Hornblower and Spawforth 1996, 1168–1169.
- Steavenson, W.H. 1956. 'Shadows Cast by Venus'. *Journal for the British Astronomical Association* 66:264–265.
- Stephenson, F.R. 2000. 'A Lunar Occultation of Mars Observed by Aristotle'. *Journal for the History of Astronomy* 31:342–344.
- Tannery, P. 1899. 'Sur Heraclide du Pont'. *Revue des études grecques* 12:305–311 (= Heiberg and Zeuthen 1929, 9.253–259).
- Tarán, L. 1974. 'Nicomachus of Gerasa'. See Gillispie 1970–1990, 9.112–114.
- 1975. *Academica: Plato, Philip of Opus, and the Pseudo-Platonic Epinomis*. Philadelphia, PA.
- 1987. 'Syrianus and Pseudo-Alexander's Commentary on *Metaph. E–N*'. Pp. 215–232 in Weisner, J. 1987. ed. *Aristoteles. Werk und Wirkung. Paul Moraux gewidmet*. vol. 2. Berlin/New York.
- Taylor, A.E. 1928. *A Commentary on Plato's Timaeus*. Oxford.
- Thiel, R. 1999. *Simplikios und das Ende der neuplatonischen Schule in Athen*. Stuttgart.
- Thoren, V.E. 1971. 'Anaxagoras, Eudoxus and the Regression of the Lunar Nodes'. *Journal for the History of Astronomy* 2:23–38.

- Tihon, A. 2010. 'An Unpublished Astronomical Papyrus Contemporary with Ptolemy'. Pp. 1–10 in A. Jones ed. *Ptolemy in Perspective: Use and Criticism of his Work from Antiquity to the Nineteenth Century*. Archimedes 23. Berlin/Heidelberg/New York.
- Timpanaro Cardini, M. 1958–1964. ed. *Pitagorici. Testimonianze e frammenti*. 3 vols. Florence.
- Todd, R.B. 1972. 'Epitêdeiotês in Philosophical Literature: Towards an Analysis'. *Acta Classica* 15:25–35.
- 1976. *Alexander of Aphrodisias on Stoic Physics: A Study of the De mixtione with Preliminary Essays, Text, Translation, and Commentary*. Leiden.
- 1984. 'Philosophy and Medicine in John Philoponus' Commentary on Aristotle's *De Anima*'. Pp. 103–110 in J. Scarborough ed. *Symposium on Byzantine Medicine*. Dumbarton Oaks Papers 38. Washington, DC.
- 1990. ed. *Cleomedis caelestia*. Leipzig.
- 2001. 'Cleomedes and the Problems of Stoic Astrophysics'. *Hermes* 129:75–78.
- 2008. rev. Baltussen 2008. *Aestimatio* 5:209–223.
- Todd, R.B. and Bowen, A.C. 2009. 'Heraclides on the Rotation of the Earth: Texts, Context and Continuities'. See Fortenbaugh and Pender 2009, 155–183.
- Toomer, G.J. 1978. *Hipparchus*. Pp. 207–224 in vol. 15 of Gillispie 1970–1990.
- 1984. *Ptolemy's Almagest*. New York/Berlin/Heidelberg.
- Tredennick, H. 1933–1935. trans. *Aristotle: The Metaphysics*. 2 vols. Cambridge, MA/London.
- Tuominen, M. 2009. *The Ancient Commentators on Plato and Aristotle*. Berkeley/Los Angeles.
- van der Waerden, B.L. 1988. 'The Motion of Venus, Mercury and the Sun in Early Greek Astronomy'. *Archive for History of Exact Sciences* 26:99–113.
- Ver Eecke, P. 1959. *Les Sphériques de Théodose de Tripoli. Oeuvres traduites pour la première fois du grec en français avec une introduction et notes*. Paris.
- 1982. *Pappus d'Alexandrie. La Collection mathématique. Oeuvre traduite pour la première fois du grec en français avec une introduction et notes*. vol. 2. Paris.
- Vitelli, H. 1887–1888. ed. *Ioannis Philoponi in Aristotelis physicorum libros commentaria*. 2 vols. Commentaria in Aristotelem Graeca 16–17. Berlin.
- von der Muehl, P. 1922. ed. *Epicuri epistulae tres et ratae sententiae a Laertio Diogene servatae*. Leipzig.
- von Staden, H. 1989. *Herophilus: The Art of Medicine in Early Alexandria*. Cambridge/New York.
- Wachsmuth, C. and Hense, O. 1884. edd. *Ioannis Stobaei anthologium*. vols. 1–2. Berlin.
- Watts, E.J. 2004. 'Justinian, Malalas, and the End of Athenian Philosophical Teaching in A.D. 529'. *The Journal of Roman Studies* 94:168–192.
- 2005. 'Where to Live the Philosophical Life in the Sixth Century? Damascius, Simplicius, and the Return from Persia'. *Greek, Roman and Byzantine Studies* 45:285–315.
- 2006. *City and School in Late Antique Athens and Alexandria*. Berkeley/Los Angeles/London.
- Wehrli, F. 1969. ed. *Die Schule des Aristoteles. Texte und Kommentar. Heft 8: Eudemos von Rhodos*. Basel/Stuttgart.

- Wildberg, C. 1987. *Philoponus: Against Aristotle on the Eternity of the World*. London.
- 1991. *Simplicius: Against Philoponus on the Eternity of the World*. Ithaca, NY.
- 1999. 'Impetus Theory and the Hermeneutics of Science in Simplicius and Philoponus'. *Hyperboreus* 5:107–124.
- 2006. 'Philosophy in the Age of Justinian'. Pp. 316–340 in M. Maas ed. *The Cambridge Companion to the Age of Justinian*. Cambridge.
- 2008. 'John Philoponus'. In E.N. Zalta ed. *The Stanford Encyclopedia of Philosophy*. <http://plato.stanford.edu/>.
- Williams, C. 2007. rev. Bowen and Todd 2004. *International Journal of the Classical Tradition* 13:476–479.
- Yavetz, I. 1998. 'On the Homocentric Spheres of Eudoxus'. *Archive for History of Exact Sciences* 51:221–278.
- 2001. 'A New Role for the Hippopede of Eudoxus'. *Archive for History of Exact Sciences* 56:69–93.
- 2003. 'On Simplicius' Testimony Regarding Eudoxan Lunar Theory'. *Science in Context* 16:319–329.
- Zeyl, D.J. 2000. *Plato: Timaeus Translated with Introduction*. Indianapolis/Cambridge.
- Zhmud, L. 1998. 'Plato as "Architect of Science"'. *Phronesis* 43:211–244.

INDEX OF PASSAGES

Agathias

Hist.

2.30.3–4 3
2.30.3–31.4 3

Alexander

De an.

29.1–4 138
30.24 46

In meteor.

143.12–14 101, 136

Περὶ ἀρχῶν

Quaest.

1.1 2.20–4.26 75
1.25 276
1.25 39.9–41.19 75

[Alexander]

In meta.

702.36–706.15 268
702.38–706.15 164
703.10–24 143
703.12–23 147
703.14–16 268
703.23–28 146, 262
704.9–10 153
704.23–705.6 156
705.25–39 162
705.39–706.13 163
706.13–15 164
706.16–17 169
706.23–24 169

Aratus

Phaen.

78 115
467 262
737 115

Archimedes

Aren.

1.4–7 252–254

Aristotle

An. post.

1.9 76a4–13 44
1.13 78a31–b4 219
1.13 78b4–11 219
1.13 78b34–39 44

De caelo

1.1–4 91
1.2 114, 286
1.2 268b11–13 27
1.2 268b14–16 27
1.2 268b14–269a9 285
1.2 268b17–24 27
1.4 101, 104
1.5 30
1.7 274b33–275a5 142
1.8 277b12–24 125
2.2 286a3–7 122
2.5 209
2.6 288a13–17 208
2.8 9, 10, 63, 111
2.8 289a26–35 277
2.8 289b1–4 8, 50
2.8 289b1–290a7 29
2.8 289b4–5 8
2.8 289b5–290a7 8
2.8 289b30–290a5 207
2.8 290a7–12 112
2.8 290a7–24 29, 32
2.8 290a7–29 8, 221
2.8 290a12–14 9
2.8 290a17 29
2.8 290a17–18 29
2.8 290a18–24 29
2.8 290a22 29
2.8 290a33–b11 32
2.8 290a35–b7 113

De caelo (cont.)

2.8 290a36-b11	8-9
2.9	9, 120
2.9 290b12-291a6	9
2.10	62
2.10 291a29	201-202
2.10 291a29-32	52
2.10 291a29-34	201
2.10 291a29-b10	97
2.10 291a30	203
2.10 291a31-32	98
2.10 291a32	52
2.10 291b9-10	203-204
2.10-12	7-10, 51
2.11	63
2.11 291b11-17	77, 111
2.11 291b17-18	9
2.11 291b17-23	52, 114
2.12	63, 68
2.12 291b24-28	52
2.12 291b24-292a18	119-120
2.12 291b35-292a1	223-224
2.12 292a3-6	115, 224-225
2.12 292a3-9	52
2.12 292a7-9	295
2.12 292a14-17	77
2.12 292a14-18	52
2.12 292a17-22	202
2.12 292a18-21	227-229
2.12 292a18-22	52, 77
2.12 292a18-b10	122-123
2.12 292a20-21	102
2.12 292b10-25	129
2.12 292b15-30	79
2.12 292b25-30	139
2.12 292b29	79
2.12 292b29-30	261-262
2.12.292b30	79
2.12 292b30-293a4	69, 79, 140
2.12 293a4-8	202
2.12 293a4-11	142
2.13 293b30-32	255
2.13-14	8, 10
2.14 297a2-6	255
2.14 297a8-b23	42
2.14 297b23-30	219
2.14 297b23-298a8	42
4.4	125

De gen. an.

1.23 741a4-26	123
---------------	-----

De gen. et corr.

2.4 331a20-b4	138
2.10 336a15-b24	277
2.11	209

De part. an.

1.1 639b21-640a2	209
1.5 644b22-645a5	122

Eth. Nic.

4.3 1125a12-16	258
----------------	-----

Meta.

Δ.5	209
Λ.6 1072a9-18	277
Λ.6-7	273
Λ.7 1072a21-24	277
Λ.8	14, 33, 59, 65- 67, 79, 81, 84, 86, 91, 92, 146, 164, 168, 223, 228, 247, 262, 268

Λ.8 1073b1-3	137
Λ.8 1073b10-11	168
Λ.8 1073b11-17	168
Λ.8 1073b17-32	274
Λ.8 1073b24-27	161
Λ.8 1073b32-38	153
Λ.8 1073b37-1074a12	274
Λ.8 1073b38-1074a5	154
Λ.8 1074a2-4	156
Λ.8 1074a6-14	162
Λ.8 1074a7-8	163
Λ.8 1074a8	162
Λ.8 1074a12-14	79, 87, 163
Λ.8 1074a14-17	169

Meteor.

1.6 343b2-34	289
1.6 343b28-30	121, 295
1.6 343b30-32	121
1.7 344a8-13	125
1.9	277
2.4	277

Phys.

1.9	54
2.2	40, 51, 203
2.2 193b22-35	38-40, 51
8.10	13

[Aristotle]		41.12-18	242
<i>Mech. Prob.</i>		41.20-42.5	242
1	159	42.5-9	243
<i>Περὶ ἐνχρήσ</i>	130	42.10-16	243
<i>Phys. prob.</i>			
15.4	168	Euclid	
		<i>Elem.</i>	
Cleomedes		1 dem. 13	172
<i>Cael.</i>		1 dem. 16	172
1.1.115-119	104	1 dem. 20	159
1.2.20-43	150	1 dem. 32	172
1.2.22-24	213	5 defs 3-4	253
1.2.49	265	5 defs 4-5	97
1.2.74	265	<i>Opt.</i>	
1.4.49-71	106	dem. 54	108
1.4.72-89	265		
1.5.1-125	42	Galenus Gram.	
1.5.126-145	42	<i>Alleg.</i>	
2.1.26-44	290	331.7-9	138
2.1.310-311	43		
2.1.332-333	43	Geminus	
2.3.15-43	292	<i>Intro. ast.</i>	
2.3.81-91	104	1.1-3	146
2.4.1-5	265	1.13-41	292
2.4.1-9	221	1.19-22	258-259
2.4.95-107	42	1.23-30	150
2.4.108-115	249	1.24	213
2.5	116	1.31-41	43, 47, 106
2.5.139-141	106	2.2-6	116
2.5.141-147	266	2.16-26	116
2.6.9	265	6.1-4	265
2.6.96	265	8.1	205
2.7.8-10	271	9.16	205
		10.1-6	206
Diogenes Laertius		10-11	43
<i>Vitae</i>		12.14-27	109
2.133	283	12.19-21	109
7.132-133	41, 44	12.22-24	109
9.113	283	12.30	134
10.77-80	48	18.1	43
10.90-98	48		
		Heron	
Epicurus		<i>Mech.</i>	
<i>Ep. ad Pyth.</i>		18.28-22.3	159
27.13-28.6	242		
28.7-29.6	242		
31.6-10	242		

Hipparchus		<i>Simplicii in de caelo</i>	
<i>In Arat.</i>		34.41	13
1.1.8	263	36.82	14
1.9.1	262	158.70	7
1.9.2	262	180.7	7
1.9.3–13	263		
1.9.9	263	MUL.APIN	
2.1.19–22	264	2.1.39	150
2.2.19	264	2.1.64	150
<i>Hippiatrica Berol.</i>		P. Hibeh 27	246
106.1	272		
Iamblichus		P. Par. gr. 1	
<i>De myst.</i>		col. 5	150, 269
9.4.20–25	206	col. 19.16–17	249
		col. 23	153
Moerbeke		PSI XV 1490	46
<i>Frag. Tolet.</i>			
	17	Pappus	
3.1.17	145	<i>Coll.</i>	
3.2.10	146	6	40
3.4.14	148	7.35	145
3.5.13	149	<i>In Alm.</i>	
3.6.3	150	1.90–93	166
3.6.6	271		
3.6.8–9	150		
3.6.11	150	Philoponus	
3.7.16.	272	<i>De aetern.</i>	
3.9.7	154	579.14–18	287
3.9.9	154		
3.9.12–17	278	Philostratus	
3.9.15	277	<i>Vita. Apoll.</i>	
3.11.11–12	156	8.23.1–4	250
3.11.15	156		
3.11.18	157	Plato	
3.12.11–12	157	<i>Crat.</i>	
3.12.15–16	158	392b1–393b6	250
3.15.12	160	<i>Leges</i>	
3.15.16	280	767c6	240
3.17.2	162	821b3–822d1	137, 232
3.17.17–19	163	822a4–8	137
3.20.1–8	291	954e4	240
<i>Simp. phil. in de caelo</i>		955e6–7	138
128.col.A	7	<i>Pol.</i>	
165.col.A	53	269a1–5	238, 240
177.col.A	168, 295	269c4–d4	238, 240
		269e3	238
		270b10–c2	240

<i>Resp.</i>		Pliny	
533c7-d4	10	<i>Nat. hist.</i>	
616e8-617a1	120	2.32	213
616e8-617a4	105	2.37	289
617a4-b4	239, 269	2.39	289
617a7-b3	107	2.68	167
617b1-2	107		
<i>Soph.</i>		Plotinus	
254a4-b1	10	<i>Enn.</i>	
<i>Tim.</i>		3.1.5-4	205
34b10-39e2	208		
35a1-b3	234	Plutarch	
35a1-40d5	137	<i>De facie</i>	
35b4-36c2	235	923a	251-253, 255,
36b6-d6	133		258
36c2-d7	235	925c	207
36c4-d1	214	932b-c	250
37a5	238	935d	292
37c6-d7	133	937f	167
38c3-6	240	939a-b	167
38c7-d1	236	<i>Plat. qu aest.</i>	
38c7-d2	120	1006b-c	256-257
38d2-4	109, 269	<i>Qu aest. conv.</i>	
38d2-6	234, 236	669a	7
38d4-6	110		
38e3-6	236	[Plutarch]	
38e6	214	<i>Plac.</i>	
38e6-39a3	106	895e6-7	138
39a1	214		
39a2	107	Proclus	
39a2-3	107	<i>Hyp. ast.</i>	
39d7-e2	240	1.34-35	298
40a2-b8	32	3.26-28	265
40a8	221	4.12	265
40b8-c3	255	4.71-72	166
40c3-d3	232-239	4.72	137, 166
40c4	205, 233	4.87-96	166
40c5	238	4.95	249
41d4-e1	262	4.97	249-251
		4.98	165
[Plato]		7.4	134, 135
<i>Epin.</i>		7.13-15	88, 290
986a8-987d2	241	7.18	250
986e3-7	236	7.19-23	212
987a1-6	121	<i>In Euc.</i>	
987b2-5	236	71.18-19	250
987c4-5	150	112.4-5	273

<i>In Euc. (cont.)</i>		88.26	44
126.24-127.3	273	88.29-47	47
128.2-5	273	<i>Nat. quaest.</i>	
<i>In rem pub.</i>		7.2.3	254-255
1.41.11-12	250		
1.170.15-16	250	Sextus Empiricus	
2.43.25	137	<i>Adv. math.</i>	
2.113.8-9	251	10.174	255
2.167.10-11	250	<i>Pyrr. Hyp.</i>	
2.230.3-15	282	1.180-182	48
2.230.14-15	212	1.181	46
2.300.23	137		
<i>In Tim.</i>		Simplicius	
2.105.32-106.2	250	<i>In cat.</i>	
3.58.24-25	250	7.29-32	61
3.62.22-24	212	22.15	270
3.62.24-63.20	212, 213	121.13	270
3.95.34-96.32	137	331.27	270
3.146.7-9	205	394.12	270
3.149.13-16	206	438.33-36	10
		<i>In de caelo</i>	40, 92
Ptolemy		1.1-6.27	11, 68
<i>Alm.</i>		1.4-2.5	290
1.3	290	3.8-12	5
1.24.8-10	49	4.25-5.34	56
3.3	46	4.25-31	11, 68
3.4	211	4.31-5.37	68
3.9	264	4.34-5.4	138
5.8-9	266	5.35-37	11
5.13-16	98, 207	5.35-6.4	5
5.14	166, 249	8.11-12	27
5.15	105	9.21	296
6.5	266	10.28-11.30	27
6.7	292	11.7-10	28
9.3	269	12.16-27	34
12.1	46, 244-247	12.29-31	34
<i>Can. man.</i>	14, 287	13.22-14.29	12
<i>Hypoth. plan.</i>	32, 70, 153, 169,	14.27-29	27
	211, 212, 282,	14.31-15.2	27
	283, 289	15.22-31	27
<i>Opt.</i>	290	16.16-26	138
<i>Tetrabib.</i>		16.18-26	34
1.13	116	16.30-34	138
		17.20-32	138
Seneca		17.20-33	34
<i>Ep.</i>		21.33-23.10	12
88.21-28	47	23.11-31	12

23.31-24.21	12	87.29-88.2	30
24.17-20	138	90.13-18	30
24.21-25.21	213	104.5	270
25.22-26.17	12-13, 33	106.4-6	33
25.23	12	107.12-13	54
26.11-15	33	119.7-13	33
26.17-19	14	119.12-13	7
26.17-21	30	135.9-10	33
26.19-21	13, 14	135.31-136.1	7
26.22-25	33	137.17-28	54
26.28-31	13, 33	138.15-22	54, 55
26.30	13	141.19-21	10
32.1-7	14	143.9-17	30
32.1-11	27, 34, 59, 80	143.9-22	61
32.1-33.16	62	154.12-16	54
32.4-11	28	157.1-12	30
32.9-11	88	157.19-21	30
32.12-16	67, 80	164.21-23	30
32.12-29	65, 84	173.23-30	30
32.12-32	28	178.26-28	30
32.12-33.16	28, 284-288	185.23-186.1	30
32.16	64	196.23-33	30
32.23-28	85	271.19	3
32.24-33.16	62	286.2-13	12
32.29-32	37	287.2-12	61
32.32-34	28	297.1-298.26	61
32.32-33.36	28	304.1	54
32.34-33.13	28	311.32	54
33.13-14	28	316.3	11
33.14-16	28	353.3-10	61
34.5-7	33	360.20-29	54, 61
35.31-33	33	361.5-364.14	18
35.33-35	33	370.29-371.4	6
42.6-16	12	371.1-4	30
50.15-18	33	372.15	54
50.18-52.18	12	377.20-24	30
65.9	30	377.20-34	60
69.11-15	61	377.24-25	80
70.16-19	30	377.29-34	33
70.17-18	33	377.32	60
74.4-5	10	378.20-21	33
74.4-7	30	431.30-32	290
80.23-26	33	444.18-445.7	50
81.10-11	33	452.9-453.21	29
84.11-85.15	34	453.22	29
85.24-31	30	453.22-25	29
87.1-8	54	453.25-34	29

In de caelo (cont.)

453.25-454.14	29	474.14-28	76
454.12	204	474.21-28	34
454.15-18	30	474.26-28	85, 211-213
454.18-22	30	474.30-32	76, 80
454.23	30	474.32-475.8	76
454.24	31	475.2-4	213-214
454.27-28	31	475.11-12	214-215
454.28-455.11	32	477.3-4	16
455.11-456.22	32	477.5-478.32	111-114
456.22-27	32	477.24-27	77
456.23	296	477.24-478.14	63
462.20	85	477.27-478.3	77, 79
462.20-21	3	478.8-14	77
462.20-31	85-86, 89	479.3-480.23	114-117
462.21	85	479.12	217-218
462.23	85	480.10-15	218-219
462.24-26	85	480.17-19	219-220
469.21-30	52-53	480.19-21	220-221
469.23	53	480.21-23	221
470.27-491.11	18	480.26-481.30	120-122
470.27-510.35	18	481.12-15	225-226
470.29-471.12	63	481.22-24	77, 80, 226-
470.29-477.2	97-110		227
471.1	204-205	481.25-26	77
471.1-4	81	481.26-30	77
471.4-6	81	482.3-485.2	123-129
471.4-11	63	483.15-19	10
471.6-11	81	483.19	54
471.9	205-206	485.5-10	77, 79
471.9-11	84, 85	485.5-489.30	130-139
471.11	206-207	485.10-12	77, 229-230
471.20	207-208	485.12-29	78
472.4-7	75	487.4-10	36
472.5-7	208-209	487.15-488.1	36
472.8-15	36, 74, 75, 79	487.20-488.2	55, 230
472.13-14	209	487.20-488.9	63
472.15-20	75	488.3-9	82
472.21-473.7	75	488.7-18	82
473.1-6	36	488.9-14	63
473.6-474.6	36	488.10-14	37, 50
473.7-474.6	75, 79	488.14-18	51, 62, 64
473.8-474.1	36	488.18-24	64, 81, 86
473.15	209-210	488.19-20	81, 83
473.26-27	210-211	488.20	248-251
473.28-474.1	211	488.21-24	251
474.7-13	76, 80	488.25-27	37
		488.25-30	70

488.25-489.4	64, 70	497.24-504.3	273-277
488.27-30	260-261	498.1-10	87
488.29-489.1	71	498.1-503.27	65
488.30-489.4	36	498.5-10	277-278
488.31	71	498.10-499.1	87
489.1-4	71	499.16-501.11	87
489.5-11	64	501.12-21	87
489.12-13	78, 80	501.22-26	87
489.12-30	64	501.26-502.19	87
489.13-21	78	502.2-3	37
489.13-30	80	502.10-11	278-283
489.16-17	54	502.19-27	87
489.22-30	78	502.32-34	80
489.33-490.16	139-140	503.10-32	79
489.33-492.24	64	503.27-504.3	65
490.6-16	36	503.29-32	87
490.19-491.11	69, 140-142	503.32-34	79
491.1-2	79, 80	503.35-504.3	79, 87
491.3-11	79	504.4-9	87
491.6	54	504.4-15	65
491.15-510.35	142-177	504.16-20	89
492.24-28	64	504.16-25	66
492.25-28	37	504.16-505.19	59, 66
492.25-31	32	504.16-507.8	70
492.25-504.32	17	504.17-20	87
492.25-510.35	27	504.20-25	67
492.28-510.35	59, 64	504.20-505.19	87-89
492.31-493.11	64	504.24-25	283-284
493.9-11	65, 66	504.28-29	288-289
493.11-497.5	65	504.29-30	289-290
493.11-497.24	89	504.30-32	290-291
493.15-17	262-264	504.33	291
494.9-12	264	504.33-505.1	291-292
494.20-22	264-265	505.11-17	292-293
495.5-8	265	505.17-19	66
495.10-13	265-266	505.19-506.8	66
495.13-16	266-268	505.21-23	293-294
495.23-29	76, 268-269	505.23-30	66
495.29	269-271	505.27-506.8	70
496.6-9	271-272	505.30	270
496.27-28	272	506.2	294
497.3	272-273	506.8-10	28, 32
497.6-24	65	506.8-16	67
497.17-18	84	506.9-16	59
497.17-22	83	506.11-15	295
497.22-24	83	506.16	296
497.24-498.1	65	506.16-22	85, 282

In de caelo (cont.)

506.22	296	291.7-20	40
507.12-14	88, 297-298	291.18-20	40
509.16-26	70	291.21	11
509.16-510.8	31	291.21-292.3	41
509.21-22	69	291.22	41
509.22-26	69	291.25-31	41
509.26-28	86, 87	292.3-15	42-43
510.8-23	69	292.4	42
510.14-26	86	292.10	42
510.19	69	292.11	42
510.19-23	85	292.13-15	43, 44
510.24-26	70, 87	292.14	43
510.24-31	70	292.14-18	47
510.26-31	86	292.15-20	46
510.31-34	31, 32	292.16	46
510.31-35	37-38	292.16-17	49
510.33	5	292.16-18	46
587.26-588.3.	61	292.18	46
647.27-28	61	292.19-20	46
662.32-663.6	213	292.20	46
663.27-664.4	213	292.20-23	49
679.27-31	61	292.21	49
710.14	296	292.22-23	49
731.25-29	10, 28, 33,	292.23-31	50
	54	292.26	50
		292.29-31	41
		292.30	50
		292.32-293.15	51

In Epict. ench.

35.16-30	55	293.7-15	39
38.368-390	54	295.12-18	60
454.6-15	10	373.3-18	49
<i>In phys.</i>	40	378.3-19	49
8.28	207	524.21	270
59.23-24	3	601.9	3
59.30-31	3	611.11-12	3
129.32	11	619.20	270
183.18	3	622.26-28	54
192.14	3	630.35	3
198.17	3	642.17	3
250.13-17	54	644.10	3
255.3-16	54-55	774.28-29	3
255.13-14	55	778.27	3
276.7	270	795.4-5	3
290.3	38	795.12-14	3
290.3-9	39	795.14	3
290.9-26	39	795.16	11
290.14	39	795.34	11
290.27-291.7	39		

1141.16-19	54	122.25-28	139
1141.21-25	54	122.25-123.9	139
1141.22-30	54	123.3-4	139
1143.26-29	54	123.5-9	140
1145.7-1147.9	54	123.9-10	140
1158.4-5	54	123.9-30	139
1326.38-1327.11	13	123.21-23	141
1337.20-33	54		
1363.8-9	3	Theodosius	
		<i>Sphaer.</i>	
Stobaeus		dem. 11-15	160
<i>Anthol.</i>			
1.22 §1d.2-4	138	Theon	
<i>Ecl.</i>		<i>Exp.</i>	
1.25 3k	255	120.15-19	206
		122.24-123.4	206
Strabo		131.4-9	206
<i>Geog.</i>		134.13-135.6	265
2.3.8	47	135.12-21	265
		147.14-19	108
Themistius		148.5-10	206
<i>In de caelo</i>		150.7-12	166
118.8-12	99	156.20-157.12	88
118.12-24	99	164.14-17	88
118.32-37	112	166.10-13	46
118.37-119.2	112	173.5-9	88
119.12-15	125	178.3-184.23	146
119.30-33	227	187.5-13	206
119.38-120.4	125	189.7-18	146
120.8-16	125	192.2-193.11	206
120.16-38	126	194.13-195.4	266
121.6	129	194.20-195.4	206
121.8-9	129	201.7-13	106
121.24-27	131		
121.28-29	229	<i>Vita Arati IV</i>	283, 284
121.28-31	132		
121.40-122.11	229	Vitruvius	
122.9	229	<i>De arch.</i>	
122.10-20	229	9.1.5-14	47
122.24-35	139	9.1.14-15	213

PASSAGES IN I.G. KIDD 1988–1999, VOL. 1

F14–15	41	F18.31–35	47
F16–17	41	F18.32–39	46
F18	41	F18.33–34	46
F18.1	41	F18.33–35	46
F18.1–18	41	F18.35	49
F18.2	41	F18.36	46
F18.7	41	F18.37–38	46
F18.17	43	F18.38	43
F18.18–30	43	F18.39	46, 49
F18.18–32	42–43	F18.39–42	49
F18.19	42	F18.40	49
F18.21	42	F18.41–42	49
F18.23–24	42	F18.42–52	50
F18.26	42	F18.46	50
F18.27	42	F18.50–53	41
F18.30–32	43, 44	F18.51	50
F18.31	43	T72	41

INDEX OF NAMES

PRE-MODERN NAMES

- Adrastus of Aphrodisias, 46
 Aenesidemus, 46, 48
 Agathias of Myrina, 3, 4
 Alexander of Aphrodisias, 11, 12, 27, 29,
 30, 40, 41, 46, 60–61, 64, 73, 74, 77, 79,
 86, 101, 105, 106, 112, 115, 122, 130, 136,
 137, 141, 164, 208, 213, 226, 229, 257,
 284, 286
 on isodromy, 76
 on rotating spheres, 76
 on sublunary elements, 78
 on teleology, 75
 Alexander of Macedon, 169, 246, 295
 Ammonius, son of Hermeias, 3, 14,
 85
 Anaximander, 63, 65, 66, 83, 98
 Apollonius of Perga, 46, 244–247
 Apollonius of Tyana, 298
 Aratus, 283
 Archimedes, 255, 256
 Aristarchus, 84, 98, 99, 207, 251–256,
 258
 Aristotherus, 165, 283–284
 Aristotle, 8–11, 27–32, 34, 37–40, 51–52,
 63–65
 and Callippus, 64–67
 and Plato, 30–34, 60–61
 on cosmic ἀρμονία, 9
 Attalus, 262, 263
 Autolycus, 67, 165, 293, 297

 Babylonians, 121, 225
 Bate, H., 291, 292
 Berossus, 221

 Calcidius, 214
 Callippus, 52, 64, 65, 67, 84, 86, 145,
 153, 154, 163, 165, 223, 248, 276, 293,
 297
 Callisthenes, 169, 295
 Chosroes, 3, 4
 Cicero, 214, 259, 297
 Cleanthes, 251, 257
 Cleomedes, 42, 47, 136
 Ctesiphon, 3, 5

 Damascius, 3, 4
 Diodorus Siculus, 231
 Diogenes Laertius, 41, 44
 Diogenes of Phrygia, 3

 Egyptians, 121, 225
 Epictetus, 5
 Epicurus, 48, 109, 241
 Euclid, 145
 Euctemon, 153
 Eudemus, 63, 64, 73, 80, 84, 98, 136, 153,
 268
 and Sosigenes, 81–83
 on Anaximander, 81
 on Callippus, 83–84
 Eudorus, 297
 Eudoxus, 52, 64, 65, 81, 82, 92, 136, 145–
 147, 154, 165, 223, 228, 263, 266, 276,
 293, 294, 297
 Eulamius (Eulalius), 3

 Galen, 296
 Geminus, 41, 43, 47, 50, 109, 258, 259
 Grosseteste, R., 16, 17, 114, 123

 Harrân (Carrhae), 4
 Heraclides of Pontus, 20, 49, 50
 Heraclitus, 7
 Hermes of Phrygia, 3
 Herophilus, 296
 Hipparchus, 84, 99, 206, 207, 263, 276,
 285

- Iamblichus, 88, 171, 297, 298
 Isadore of Gaza, 3
 Justinian, 3
 Kepler, J., 213
 Levi ben Gerson, 166
 Menecrates of Ephesus, 283
 Menedemus, 283
 Meton, 153
 Michael of Ephesus, 143
 Nicomachus of Gerasa, 88, 171, 297, 298
 Nigidius Figulus, 297
 Pappus, 40
 Philip of Opus, 241
 Philoponus, 6, 7, 8, 11–15, 27–28, 30–31,
 33, 34, 38, 40, 56, 57, 59–60, 62, 71, 91,
 173, 284, 287
 Plato, 11, 28, 33, 34, 64, 76, 81, 82, 88, 106,
 107, 120, 136, 137, 145, 273, 288, 293, 297
 Pliny, 88
 Plotinus, 164, 205
 Plutarch, 207, 251, 255, 292
 Polemarchus, 145, 167, 293, 297
 Porphyry, 79, 80, 164, 169, 295
 Posidonius, 41, 47, 50, 136, 257
 his treatise, 41
 Posidonius/Geminus, 41, 43, 44, 46, 49,
 50
 Priscian of Lydus, 3, 4, 41
 Proclus, 3, 40, 86, 88, 205, 212, 248, 249,
 273, 282, 287, 296, 298
 Ptolemy, 14, 32, 40, 46, 49, 59, 63, 73, 76,
 81, 84–86, 91, 99, 105, 169, 207, 226,
 249, 269, 282, 285, 290, 291, 296
 hypotheses, 37
 Pythagoreans, 63, 65, 66, 81, 88, 98, 171,
 258, 259, 291, 297–298
 on cosmic ἀρμονία, 9, 83, 120
 Pythocles, 241
 Seleucus, 256
 Seneca, 47, 254, 255
 Severus Sebokht, 287
 Simplicius
 and Ptolemy, 211–213, 296
 cosmology, 34–36
 life, 3–4
 predicament, 10–15
 readers, 5–6
 resources, 6
 style, 18
 work, 4–5
 Sosigenes, 64, 65, 73, 81–83, 86–87, 89,
 101, 136, 154–156, 160–165, 174, 176,
 249, 268, 276, 278, 281
 Sosigenes/Simplicius, 161, 278
 Stobaeus, 255
 Strabo, 47
 Syrianus, 143
 Themistius, 73, 99, 112
 Theon of Alexandria, 40
 Theon of Smyrna, 46, 88
 Theophrastus, 87, 143, 146, 164, 268
 Thomas Aquinas, 17
 Timocharis, 226
 Timon, 283
 Vitruvius, 47, 231
 William of Moerbeke, 17, 18
 Xenarchus of Seleucia, 11, 12
 Zeno of Citium, 44

MODERN NAMES

- Allan, D.J., 17
 Aujac, G., 47, 165, 168, 292

 Baltussen, H., 4, 7, 83
 Beere, J., 162, 273
 Berggren, J.L., 41, 43, 47
 Bodnár, I., 275–276
 Bossier, F., 15, 17, 18

 Dicks, D.R., 224, 266

 Easterling, H.J., 223–224
 Elders, L., 115, 128, 228
 Evans, J., 41, 43, 47

 Farhat, T., 170, 280, 283

 Goldstein, B.R., 246, 247
 Golitsis, P., 4
 Grant, R., 250

 Hadot, I., 4
 Heath, T.L., 20, 234, 253, 255, 256,
 264, 266
 Heiberg, J.L., 17–19, 119, 165, 205, 209,
 217, 218
 Herald, D., 224–225
 Hoffmann, P., 7, 11

 Ideler, L., 266

 Johansen, T., 227
 Jones, A., 41, 46

 Kidd, I.G., 41, 46

 Leggatt, S., 208

 Mendell, H., 135, 263, 267–268
 Montelle, C., 271
 Moraux, P., 16, 17
 Mueller, I., 15, 16, 43, 207, 226

 Neugebauer, O., 85, 145, 220, 245, 269,
 295

 Rescigno, A., 209
 Ross, W.D., 223

 Schiaparelli, G., 20, 88, 154, 167, 168, 247,
 266
 Steel, C., 18
 Stephenson, F.R., 225

 Tannery, P., 47, 50
 Tarán, L., 150
 Tardieu, M., 4
 Taylor, A.E., 214, 234
 Thoren, V.E., 266
 Todd, R.B., 47, 217
 Toomer, G.J., 244, 245

 Verrycken, K., 38
 von Staden, H., 16

 Walker, C., 225
 Wildberg, C., 287

 Yavetz, I., 272, 273

INDEX OF SUBJECTS

This index is supplemented by the Analytical Table of Contents.

- ἀκολούθησις, 134
ἀκροατής, 145
ἀνελίττω, 135
ἀνωμαλία, 135, 171
ἀστήρ, 119, 201
ἀστράγαλοι, 123, 126
ἀστρολόγος, 39, 204, 263
ἄστρον, 119, 201
δάκτυλος, 291
διχότομος, 114–115, 119, 218
ἐκκεντρότης, 105, 211
ἐλίσσομαι, 29
ἐντυγχάνω, 5
ἐπανακύκλησις, 233, 237–239
ἐπιχείρημα, 139
ἦκω, 272
ἵπποπέδη, 152, 272–273
καταλαμβάνω, 204–205
κατάπτυστος, 14
κόπρια, τά, 6–7
μαθηματική
 and φιλοσοφία, 39
μαθηματικός, 39, 203–204, 244,
 263
μήκος, 147
παραβολή, 99, 205
πλάτος, 147, 265
προήγησις, 134
προποδισμός, 135
προχώρησις, 233, 237
πῶς, 269–271
σύνοδος, 205
συμφωνία, 61
τις, 49
τροπή, 240
ὕπληψις, 148
ὕποποδισμός, 134
φάσις, 134
φιλονεικίῳ, 30
φιλόπονος, 11, 257
φυσική
 and ἀστρολογία, 39–45, 51–
 52
 and μαθηματική, 38–40
φωστήρ, 137
χρόνος, διέξοδος, 150

aether
 composition, 34
 motion, 34
astronomy
 its limitations, 52–53
Athens
 coordinates, 224, 225
cubit, 292
defense of
 Aristotle, 62–68, 92
 De caelo, 68–69
 late Platonists, 69–71, 92
digit, 291
dioptra, 166, 249
fixed sphere
 as hypostasis, 36, 140
fixed stars
 as ensouled, 227–229, 261–
 262
 motion, 8–9
 precession, 85–86
Jupiter, 121, 143, 153, 155, 160–162
 occultation of a star, 121
 sidereal period, 150
 synodic period, 151
knucklebones, 122, 126
Mars, 115, 119, 121, 151, 154, 162,
 165
 apparent size, 289
 sidereal period, 150
 synodic period, 151

- Mercury, 152, 154, 162, 173
 - name, 30
 - sidereal period, 150
 - synodic period, 151
 - twinkling, 30
- Moon, 115, 119–121, 125, 127, 129, 131–135, 137, 147–149, 153, 154, 162–167, 174
 - apparent size, 290–291
 - eclipse of Sun, 114, 117, 249–250
 - nodal motion, 120, 265–266
 - occultation of Mars, 115, 119, 121, 224–225
 - phases, 114–117, 119, 218
 - sidereal period, 106
 - sphericity, 114–117, 218–221
 - zigzag hypothesis, 47
- motion
 - on one's own accord, 112
- observation
 - as inference, 52–53
- planetary motion
 - as diurnal only, 108–109
 - direct, 20
 - diurnal, 20, 208
 - Goal Year, 271
 - hypotheses for, 37, 38, 47, 52
 - isodromy, 76, 80
 - proper, 75
 - retrogradation, 20–22, 134
 - awareness of, 230–248
 - rotation, 29–32
 - sidereal, 9, 149, 201, 268–269
 - synodic, 20, 150, 271–272
- planets, 20
 - apparent size, 52, 165–167
 - as ensouled, 227–229, 261–262
 - as hypostases, 36, 133, 210–211
 - inner, phases, 21
 - nesting, 34, 212
 - occultations, 225–226
 - outer, phases, 21
 - rationality, 34–36
 - sphericity, 10
- Saturn, 120, 133, 143, 153, 155, 160–162
 - names, 150
 - sidereal period, 150
 - synodic period, 151
- saving the phenomena, 251–259
- Sun, 119–121, 125, 127, 129, 131–135, 137, 146–150, 153, 154, 159, 162, 163, 166, 167
 - a third motion, 146–148, 262–264, 276
 - apparent size, 249–250
 - eccentric hypothesis, 47
 - length of day, 264–265
 - season lengths, 153
- Venus, 151, 154, 162, 165
 - apparent size, 288–289
 - brightness, 105
 - shadows cast, 289–290
 - sidereal period, 150
 - synodic period, 151
 - twinkling, 30